



ROADS AND MARITIME SERVICES NSW  
**PROSPECT HIGHWAY UPGRADE**  
FINAL DRAINAGE INVESTIGATION  
REPORT



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## ROADS AND MARITIME SERVICES

# MR644 - PROSPECT HIGHWAY UPGRADE BETWEEN RESERVOIR ROAD AND ST MARTINS CRESCENT

## Final Drainage Investigation Report

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This report has been prepared for Roads and Maritime Services in accordance with the terms and conditions of appointment for MR644 - Prospect Highway Upgrade between Reservoir Road and St Martins Crescent dated 4 April 2013. Hyder Consulting Pty Ltd (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.





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# 1 INTRODUCTION

NSW Roads and Maritime Services (Roads and Maritime) have engaged Hyder Consulting to undertake the drainage investigation in relation to the works associated with the upgrade of the Prospect Highway between Reservoir Road and St Martins Crescent. This report details the findings of the drainage investigation, concept drainage strategy and erosion sediment control requirements for the proposal.

As part of the same commissioning, Hyder Consulting have been engaged to undertake the utility investigation for the proposal. This drainage design report should be read in conjunction with the utility investigation report (FA0001-AA005690-AAR-05-Utilities Investigation & Strategy Report). The concept drainage design presented in this report was developed considering the utility investigation.

## 1.1 PROPOSAL OVERVIEW

The proposal includes the upgrading of Prospect Highway from Reservoir Road, Prospect to St Martins Crescent, Blacktown and is located within the Blacktown City Council (Council) local government area. It also includes:

- The improvement of all intersections.
- Replacement of the roundabouts at the southern section of the proposal.
- Construction of a two way access ramp from Great Western Highway.
- New shared path on the western side of the highway to connect the existing shared path between M4 Western Motorway and Harrod Street.
- Replacement of the existing pedestrian underpass at approximately CH 1980.

**Figure 1** in **Appendix A** shows the locality plan and presents the extent of the works and key features of the proposal area.

## 1.2 SCOPE OF WORKS

The scope of works covered in this report includes:

- Undertake a hydrology and hydraulic (drainage) investigation of the proposal area and areas in the vicinity of the proposal potentially affected by the proposed works.
- Undertake the pavement drainage investigation and concept design based on the proposed road design including the proposal of measures to eliminate and or reduce potential impact of the proposed works.
- Determine the erosion and sediment control requirements for the construction stage.
- Provide a 'Drainage Investigation and Design' report incorporating the items above.

## 1.3 AVAILABLE INFORMATION

The following information was made available and reviewed for the preparation of the drainage investigation and the development of the concept drainage design:

- Roads and Maritime detailed ground survey along the existing road corridor for the extent of the proposal.
- Roads and Maritime 3d utility survey model. This model also included various utilities in 2d format.
- Roads and Maritime road design models.
- Roads and Maritime pedestrian underpass bridge design.
- Roads and Maritime preliminary construction staging plans.
- Cadastral information.
- Aerial imagery information for the proposal locality supplied by Roads and Maritime.
- Drainage design drawings of the existing drainage systems constructed as part of the M4 Western Motorway and Great Western Highway.
- Blacktown City Council drainage system layout information in the vicinity of the proposal.
- Blacktown City Council plans of the stormwater detention basins located adjacent to the road at about chainage 2100.
- Two (2) metre contours CAD file for the locality.

## 2 HYDROLOGY INVESTIGATION

The Prospect Highway road corridor runs in close proximity to the catchment boundary of Greystanes Creek and Blacktown Creek. Greystanes Creek Catchment is generally located to the east of the proposal corridor and Blacktown Creek the west. The proposal does not cross major waterways and therefore is not impacted by regional (major) flooding. The Girraween Creek and Blacktown Creek are in close proximity but outside the scope of the proposal. Girraween Creek is located south of proposal limit and Blacktown Creek is located west of the Two-way Link Road and north of the proposal limit. Flooding information of Girraween Creek and Blacktown Creek was not available for the current investigation. However, the proposal is not expected to impact or be impacted by major flooding from the waterways.

It is important to note that the proposal is not within the Prospect Reservoir catchment, and runoff from the existing Prospect Highway does not discharge to Prospect Reservoir.

Runoff generated within the road corridor catchments discharge to four (4) cross drainage structures and to Council's drainage lines located along the route. Along the section of the proposal located to the north of the Great Western Highway (GWH), some road runoff escapes the road corridor through the several side streets. The following sections of this report discuss the existing drainage patterns in more detail.

The location of the existing cross drainage structures, drainage lines and other key drainage features along the proposed proposal corridor is shown on **Figures 2-1 to 2-5** contained in **Appendix A**.

### 2.1 EXISTING CROSS DRAINAGE

Four (4) cross drainage structures were identified along the corridor. The details of these structures are provided in Table 2-1.

**Table 2-1 Existing Cross Drainage Structures**

Catchment	Design Road Chainage (Approx)	Size/Type (mm)	Upstream Invert Level (m AHD)	Downstream Invert Level (m AHD)	Adjacent Road Level (m AHD)
Greystanes Creek	MC10 - 460	1350 RCP <sup>1</sup>	65.32	63.86	72.41
Blacktown Creek	MX01 - 110	750 RCP <sup>1</sup>	74.55	72.25	76.33
	MC10 - 2034	900 RCP <sup>1</sup>	64.75	63.14	70.11
	MC10 - 3100	450 RCP <sup>1</sup>	59.94	59.54	61.06

<sup>1</sup> RCP – Stands for reinforced concrete pipe.

It is important to note that there are two stormwater detention basins located at both upstream (eastern side of the road) and downstream (western side) of cross drainage structure at CH 2034. The discharge through this cross drainage culvert is inlet controlled by a complex inlet structure.

A pedestrian underpass is located approximately 55 metres south of the cross drainage culvert and would serve as emergency flow path for basin on the eastern side of the road corridor in storm larger than 100 year ARI.

## 2.2 CATCHMENT DESCRIPTION

A brief description of the catchments and their existing drainage patterns are provided below in Table 2-2. Refer to **Figures 2-1 to 2-5** for catchment location and details on the existing drainage systems.

**Table 2-2 Catchment Description Summary**

Catchment ID	Catchment System	Description
C1	Greystanes Creek	<p>Runoff from approximately 180 m of roadway (the section of Prospect Highway also called Reconciliation Road is captured and conveyed by a piped drainage system located to the south of Reservoir Road Intersection.</p> <p>Discharges from the catchment external on the western side of the road are collected by an existing catch drain that runs along the road and connects to inlet pits located along the drain. The inlet pits are linked to the road piped drainage system. The piped system discharges to Girraween Creek at approximately CH 0.</p>
C2	Greystanes Creek	<p>Runoff from the intersection of Prospect Highway and Reservoir and approximately 50 metres of roadway flows overland within the southern gutter of Reservoir Road. Runoff conveyed by the gutter discharges to the low point located near the southern end of Reservoir Road.</p>
C3	Greystanes Creek	<p>The catchment is approximately 13.9 ha in area and comprises of mostly undeveloped land and a number dwellings. The survey and contour information available indicate that the catchment extends to Watch House Road on the western end, Reservoir Road on the southern end, the M4 Western Motorway westbound entry ramp on the northern end and Prospect Highway on the eastern side.</p> <p>Runoff from this catchment discharges the inlet of the cross drainage culvert at approximately CH 460 comprised of a 1350 RCP which across Prospect Highway. Runoff from small portion of land located between the M4 Western Motorway westbound entry ramp and the M4 Western Motorway discharges flows across the westbound entry ramp via a 375 RCP to open channels that run towards the cross drainage structure at approximately CH 460.</p> <p>The cross drainage culvert at MC10 – 460 has sufficient capacity to convey the 100 year average recurrence interval (ARI) flows.</p>
C4	Greystanes Creek	<p>This catchment is comprised of approximately 140 m of Prospect Highway roadway and part of the road embankment and batter located on the eastern side of the Prospect Highway. Runoff from this catchment joins the flows from catchment C3 in the vicinity of the cross drainage structure outlet at approximately CH 460.</p>

Catchment ID	Catchment System	Description
C5	Greystanes Creek	Runoff from the M4 Western Motorway westbound exit ramp discharges to a number of small sedimentation basins located on the southern side of the M4 westbound exit ramp. The catchment is comprised of approximately 50 m of roadway.
C6	Greystanes Creek	<p>This catchment is approximately 5.9 ha in area and comprises of a large portion of the M4 Western Motorway/ Prospect Highway interchange. The interchange and the M4 Western Motorway is served by a number of drainage systems comprised of cross drainage structures, pavement drainage systems and catch drains/ open channels. These systems ultimately discharge to the M4 water quality basin located between the M4 Western Motorway and the westbound exit ramp.</p> <p>The drainage systems located to the north of the M4 combine their runoff with runoff from approximately 500 m of the M4 Western Motorway eastbound carriageway at the inlet of the existing 825 RCP cross drainage culvert. The cross culvert which conveys runoff to the existing M4 basin on the southern side of the motorway.</p>
C7	Blacktown Creek	Catchment C7 is comprised of approximately 70m of M4 eastbound exit ramp roadway. Flows from this catchment are conveyed within a SA gutter in the vicinity of the Prospect Highway. The gutter connects to an open channel that runs along the ramp towards Blacktown Creek.
C8	Blacktown Creek	C8 is comprised of an undeveloped land between the GWH and the M4 Western Motorway eastbound exit ramp. The catchment includes the section of Prospect Highway roadway between the roundabout located to the north of the M4 and to the south of the bridge over the GWH. Runoff from the roadway is captured and conveyed by a piped drainage system which discharges to an open channel at approximately CH 1120. The runoff from this catchment travels to the inlet of a 750 RCP cross drainage culvert located across the GWH.
C9	Greystanes Creek	Runoff from approximately 110 m of roadway including runoff generated within the bridge over GWH is captured by the minor piped drainage system located at the southern end of the bridge. Runoff is discharged to a catch drain located at the top of the GWH cutting on the south eastern side of the bridge. Based on as built plans for the GWH, runoff from this catchment is then discharged across the GWH in northerly direction via a 600 RCP cross drainage structure.
C10	Greystanes Creek	Runoff from C10 escapes the Prospect Highway roadway via the GWH eastbound entry ramp.

Catchment ID	Catchment System	Description
C11	Blacktown Creek	<p>Runoff from approximately 120 m of the GWH eastbound exit ramp is captured by a minor piped system and discharged to an open channel on the northern side of the ramp. Runoff from this catchment joins the runoff of C8 at the outlet of the existing GWH 750 RCP cross pipe. The GWH cross pipe discharges to the inlet of the 750 RCP which forms part of the Council's piped drainage system. The Council's 750 RCP runs through the properties located on the northern side of the GWH eastbound exit ramp.</p> <p>The drainage easement adjacent to the inlet of the 750 RCP (Council's piped drainage system) is expected to carry catchment runoff which bypasses the underground drainage system at this location. It is believed that the area would provide some flood storage before runoff starts escaping through the back (timber) fences of the properties located near the low point. However, the flood storage available is limited as the timber fences located at the rear of the properties would allow runoff to escape through and collapse depending on the water depth building up behind them.</p> <p>Hydraulic analysis indicates that the GWH cross pipe has sufficient capacity to convey the 100 year ARI storm flows.</p>
C12	Blacktown Creek	<p>This catchment is comprised of approximately 700 m length of the GWH and includes part of the GWH eastbound exit ramp. Runoff from this catchment is captured by the highway piped drainage system and discharges to Blacktown Creek located approximately 530m to the west of the Prospect Highway bridge.</p>
C13	Greystanes Creek	<p>Runoff from approximately 170 of roadway is captured by a number breaks in the SF type gutter and conveyed via chutes to a 375 RCP which forms part of the Council's piped drainage system.</p> <p>Bypass flows from this catchment contributes to catchment C15.</p>
C14	Blacktown Creek	<p>C14 is comprised a grassed area located adjacent to the existing Prospect Highway roadway. Runoff from this catchment discharges to inlet of Council's piped drainage system on the western side of the road at approximately CH 1450.</p> <p>Bypass flows from this catchment contributes to catchment C15.</p>
C15	Greystanes Creek	<p>A piped drainage system captures and conveys runoff from an approximately 160 m roadway within C15. The piped system also capture and conveys runoff from the grassed area located on the western side of the roadway and discharges to the Council's piped drainage system on the eastern side of the road</p> <p>Bypass flows from this catchment contributes to catchments C16 and C17.</p>



Catchment ID	Catchment System	Description
C16	Blacktown Creek	<p>Runoff from this catchment flows overland along the western side of the roadway and turns into the Harrod Street. Runoff is then collected by the Council's drainage system (by piped or overland systems).</p> <p>Bypass flows from this catchment contributes to catchment C15.</p>
C17	Greystanes Creek	<p>Runoff from approximately 130 m of roadway and the open space on the western side of Prospect Highway discharges to minor piped drainage system located at approximately CH 1720. The piped system connects to a 375 RCP on the eastern side of the road which forms part of the Council's piped system.</p> <p>Bypass flows from this catchment contributes to catchments C18 and C19.</p>
C18	Blacktown Creek	<p>C18 is approximately 6.3 ha in area and is predominantly formed by residential land. The area is served by a piped drainage network system which discharges runoff to a detention basin located at the inlet of the cross drainage structure at CH 2034 comprised of a 900 RCP.</p> <p>A detention basin is also located in private land at CH 2080. It should be noted that the effect of this detention basin was not considered in the current assessment as the details and dimensions were not available.</p> <p>Runoff discharge across the Prospect Highway is controlled by a complex inlet structure located at the inlet of the cross drainage structure. Site inspection determined that the inlet structure is comprised of two enclosed chambers with two 150mm PVC inlet pipes as low level inlet and a rectangular approximately 900mm by 200mm high level opening located approximately 2.2m above the invert level of the low level inlet. The top of the chambers are comprised by two 1000mm by 1000mm inlet grates which allow inflows into and surcharge out of the chambers.</p> <p>The Council piped drainage network connects to both sides of the inlet control structure with a 600mm diameter pipe on the southern chamber and a 450 mm diameter pipe on the northern chamber. The northern chamber is connected to the 900 RCP cross drainage culvert at MC10 – 2034 and estimated to have sufficient capacity to convey the 100 year ARI storm event flows. The southern chamber flows into the northern chamber via an approximately 300mm orifice.</p> <p>The cross drainage culvert at MC10 – 2034 was estimated to have sufficient capacity to convey the 100 year ARI storm event flows.</p> <p>The pedestrian underpass located at approximately CH 1980 serves as an emergency flow path during large to extreme storm events (larger than 100 year ARI) or during potential blockage of the inlet control structure.</p>

Catchment ID	Catchment System	Description
C19	Blacktown Creek	<p>C19 is approximately 6.2 ha in area is comprised predominantly of residential land. Approximately 300 m roadway and open space located adjacent to the road also form this catchment. Runoff from this catchment joins runoff from C18 (900 RCP cross drainage culvert) at the detention basin located within this vicinity.</p> <p>The basin is formed by a levee on that runs along the back of the properties on the western side of the basin. Flows discharge from the basin via a 375 mm diameter pipe and Lorne Street cul de sac located on the north western end of the basin forms the basin spillway.</p>
C20	Blacktown Creek	<p>Catchment C20 is approximately 3.5 ha in area and formed by roadways, open space and residences. Runoff from this catchment is captured and conveyed by a minor piped drainage system that connects to the Eltham Street pipe drainage network via a drainage easement located at approximately CH 2290 on the western side of the Prospect Highway.</p> <p>Runoff generated on the eastern side of the Prospect Highway and on Prospect Highway flows to the localised low point located in vicinity of the intersection of these two roads. Runoff is captured by the piped drainage system in this vicinity and conveyed across to the Eltham Street pipe drainage network.</p> <p>On the western side, runoff flows along the gutter where it is captured by a number of SA1 type inlet pits and is piped to the to the Eltham Street pipe drainage network.</p> <p>Runoff bypassing the existing piped drainage system flows to catchments C21 and C22.</p>
C21	Blacktown Creek	<p>C21 is formed by roadway catchment and the open space land at the south western corner of Lancelot Street. Runoff generated within this catchment flows overland to the west of Prospect Highway into Lancelot Street.</p>

Catchment ID	Catchment System	Description
C22	Greystanes Creek/ Blacktown Creek	<p>C22 is approximately 1.8 ha in area and comprised of 330m roadway and residential land. Runoff from the residential land to the east of Prospect Highway and from the eastern side of Prospect Highway roadway flows along the eastern gutter towards the existing low point at approximately CH 2600. On the western side of the road, runoff flows within the SO type gutter to the low point at approximately CH 2600. It is important to note that flows bypassing the piped drainage system in catchment C20 join runoff from catchment C22.</p> <p>Runoff is collected by the minor piped drainage system located in the vicinity of the low point at approximately CH 2600 and discharged east into a 450 RCP which connects into the existing Council's pipe drainage network. It is noted that the existing 450 RCP is located within the residential land adjacent the roadway and overland flow paths is blocked by dwellings.</p> <p>Flows surcharging the pipe system on the eastern side of the road are believed to impact on the residences on the eastern side of the Prospect Highway towards Greystanes Creek catchment system. This is evidenced by the number of inlet pits located within the driveway of No. 223/223A Prospect Highway property which is located immediately opposite the road low point.</p> <p>On the western side of the road, the low point is located immediately opposite No. 224 Prospect Highway property. Flows exceeding the capacity of the existing drainage system are believed to escape the roadway through this property and Shelley Public School located immediately to the north and discharge to the Blacktown Creek catchment system.</p>
C23	Greystanes Creek	<p>Runoff from approximately 120 m of roadway runs along the road verge. Runoff then escapes the proposal corridor via Vesuvius Street where it is collected by the Council's drainage network.</p>
C24	Blacktown Creek	<p>Runoff from approximately 190 m of roadway runs along the gutter on the western side of the road. Runoff then escapes the proposal corridor via Keyworth Drive where it is collected by the Council's drainage network.</p>

Catchment ID	Catchment System	Description
C25	Blacktown Creek	<p>Catchment C25 is approximately 2.3 ha in area and comprises approximately 280 m of the Prospect Highway roadway and undeveloped Roads and Maritime owned land which lies on the eastern side of the proposal corridor. The land forms part of a road reserve corridor and is earmarked for future development of a roadway to link Prospect Highway to Leabons Lane.</p> <p>Inundation of the Prospect Highway southbound shoulder approximately 55m north of the intersection with Keyworth Drive was observed during a site visit undertaken during a rainy day. A member of the community has also made this observation during the community involvement process. The inundation is believed to occur due to blockage of the inlet pit. It has also been observed during site visits that a number of pavement drainage inlet pits were silted up providing small or no capacity to capture and convey runoff.</p> <p>Survey indicates that a 375 RCP cross drainage pipe at CH 3100 conveys runoff generated by the eastern part of the catchment across the proposal corridor. The existing 375 RCP cross pipe connects to a 450 RCP pipe on the western side of the proposal corridor. The 450 RCP runs through a drainage easement and connects to the Council's pipe drainage network in the vicinity of the intersection of Beaufort Road and Hawkins Street. Survey information shows a localised low point on the eastern side of the roadway while the western side of the road shows the road is on grade allowing bypass flows to discharge to the catchment to the north (C26). It is important to note that Roads and Maritime land on the eastern side currently provides detention storage for runoff approaching the inlet of the cross drainage pipe at MC10 – 3100. The storage provided at this location attenuates the rate of flows discharging across the proposal corridor. However, the attenuation of flows provide by the storage is not sufficient to prevent surcharge during 100 year ARI storm flows. The cross drainage structure at MC10 – 3100 was estimated to have capacity to convey flow between 20 year and 50 year ARI storm event flows without surcharging.</p> <p>The western part of the catchment is served by a piped drainage system which connects to the cross drainage pipe at CH 3100. Flows bypassing this system discharges to catchment C26.</p>
C26	Blacktown Creek	<p>Runoff from approximately 240 m of roadway (existing service road) and grassed median is conveyed overland within the western road gutter. Runoff then escapes the road corridor via Tudor Avenue where it joins the Council's drainage network.</p>
C27	Blacktown Creek	<p>Runoff generated within a small area of the highway at the intersection with St Martins Crescent escapes the proposal corridor via St Martins Crescent. Runoff then flows towards Council's drainage system.</p>

Catchment ID	Catchment System	Description
C28	Blacktown Creek	<p>Catchment C28 is approximately 15.9 ha in area and comprises approximately 340 m of the Prospect Highway roadway, residential land located along the eastern side of the proposal corridor and an external sub-catchment discharging to existing trunk drainage on Prospect Highway via a 900 RCP adjacent to Cat Place. Stormwater runoff which exceeds the capacity of the 900 RCP will surcharge and was assumed to discharge on to Prospect Highway via a pathway adjacent to Cat Place. Further ground survey of Cat Place would be required to determine the escape route for surcharging flows and confirm the above assumption.</p> <p>Runoff from this catchment is captured and conveyed by a piped drainage system that runs mostly longitudinally along the eastern side of Prospect Highway. The piped drainage system ultimately connects to Blacktown Creek in the vicinity of the Prospect Highway intersection with Leabons Lane/ Bungaribee Road.</p> <p>Runoff generated within a small area of the highway northbound near the project boundary escapes the proposal corridor via the entrance of the Blacktown Mega Centre carpark.</p>

## 2.3 EXISTING HYDROLOGY

### 2.3.1 MODELLING

The DRAINS software was used to determine the existing hydrologic regime of the receiving drainage systems affected by the proposal. This assists the assessment of the potential impact the proposal will have on the existing drainage systems.

DRAINS software is suitable for performing analysis for urban drainage systems. It is a simulation program which converts rainfall patterns to runoff and routes flows through pit and pipe network systems, culverts, basins and open channels.

The initial losses of 1 mm for paved and 5 mm for grassed areas were adopted in the DRAINS model. An antecedent moisture condition of 3 was adopted. Rainfall intensities for design storms ranging between 2 and 100 year average recurrence interval (ARI) were derived using the raw rain data obtained from the Bureau of Meteorology (BoM) website for 33.80S (latitude) and 150.92E (longitude).

The catchments shown on **Figures 2.1 to 2.5** were divided into a number of sub-catchments and their characteristics were entered into the models including area, paved fractions, flow path lengths, gradients and time of concentration. A catchment summary is included in Table 2-3 below.

### 2.3.2 MODEL RESULTS (PRE-UPGRADE)

The DRAINS models were simulated for design storm events ranging between 2 and 100 year ARI. The estimated peak runoff rates at the key locations indicated on **Figures 2.1 to 2.5** are presented in Table 2-3. Table 2-3 below also summarises the catchments characteristics.

It should be noted that the peak flow location ID number corresponds with its respective catchment ID number. For example, F1 relates to the peak flows generated within catchment C1 at the catchment outlet, F2 for peak flows at outlet of C2 and so on.

Table 2-3 Pre-upgrade Peak Flows

Location	Location ID	Catchment System	Catchment Area (ha)	Imperviousness (%)	Peak Flow (m <sup>3</sup> /s)			
					2 year ARI	10 year ARI	20 year ARI	100 year ARI
Combined overland and pipe flows at southern end of the proposal limit	F1	Greystanes Creek	1.26	67	0.25	0.39	0.46	0.55
Overland flow along Reservoir Road (east of Prospect Hwy)	F2	Greystanes Creek	0.16	75	0.03	0.05	0.06	0.07

Location	Location	Catchment System	Catchment Area	Imperviousness	Peak Flow (m <sup>3</sup> /s)			
Peak flow at the inlet of cross drainage structure at MC10 - 460	F3	Greystanes Creek	13.7	22	1.69	3.12	3.68	4.69
Flows discharging to the outlet of cross drainage structure at MC10 - 460	F4	Greystanes Creek	0.76	33	1.87	3.33	3.92	5.04
Outlet of piped drainage system combining flows from M4 water quality basin and pavement drainage systems at this location	F5	Greystanes Creek	0.43	69	0.10	0.27	0.43	0.92
Inflows to M4 water quality basin	F6	Greystanes Creek	6.17	53	0.71	1.12	1.32	1.66
Overland flow down the M4 eastbound exit ramp	F7	Blacktown Creek	0.21	50	0.04	0.06	0.08	0.09
Inlet flow at cross drainage structure at GWH MX01 - 110	F8	Blacktown Creek	3.85	17	0.44	0.82	0.96	1.25
Outlet of piped drainage system discharging to catch drain at top of GWH cutting	F9	Greystanes Creek	0.15	70	0.10	0.14	0.17	0.21
Overland flow down the GWH eastbound entry ramp	F10	Greystanes Creek	0.1	100	0.01	0.02	0.02	0.03
Inlet of existing 825 RCP	F11	Blacktown Creek	1.07	24	0.61	1.09	1.27	1.65

Location	Location	Catchment System	Catchment Area	Imperviousness	Peak Flow (m <sup>3</sup> /s)			
Flows discharging to Blacktown Creek at the GWH cross drainage structure (flows exclude runoff from Blacktown Creek catchment upstream of GWH)	F12	Blacktown Creek	3.42	75	0.68	1.03	1.21	1.45
Piped flow discharging to existing Council's drainage system	F13	Greystanes Creek	0.24	100	0.02	0.02	0.02	0.02
Piped and overland flows discharging to existing Council's drainage system	F14	Blacktown Creek	1.40	6	0.23	0.4	0.48	0.58
Piped flow discharging to existing Council's drainage system	F15	Greystanes Creek	0.88	45	0.19	0.25	0.35	0.39
Overland flow down Harrod Street	F16	Blacktown Creek	0.085	100	0.02	0.02	0.08	0.22
Piped flow discharging to existing Council's drainage system	F17	Greystanes Creek	0.64	57	0.11	0.16	0.19	0.22
Piped flow through cross drainage structure at MC10 - 2034	F18	Blacktown Creek	6.31	72	0.83	0.85	0.86	0.87
Inflow to existing detention basin on the western side of the Prospect Highway	F19	Blacktown Creek	6.19	49	1.07	1.31	1.44	1.73



Location	Location	Catchment System	Catchment Area	Imperviousness	Peak Flow (m <sup>3</sup> /s)			
Piped and overland flows discharging to existing Council's drainage system	F20	Blacktown Creek	3.47	64	0.62	0.87	0.92	1.01
Overland flow down Lancelot Street	F21	Blacktown Creek	0.31	68	0.08	0.12	0.14	0.16
Piped and overland flows discharging to existing Council's drainage system to Greystanes Creek. Values between brackets represent surcharge flows escaping to Blacktown Creek	F22	Greystanes Creek/ Blacktown Creek	1.82	82	0.51 (0.01)	0.75 (0.09)	0.99 (0.12)	1.30 (0.14)
Overland flow down Vesuvius Street	F23	Greystanes Creek	0.33	86	0.09	0.13	0.15	0.17
Overland flow down Keyworth Drive	F24	Blacktown Creek	0.62	86	0.17	0.24	0.29	0.34
Piped flow from cross drainage structure at MC10 - 3100	F25	Blacktown Creek	2.31	57	0.41	0.49	0.50	0.51
Overland flow down Tudor Avenue	F26	Blacktown Creek	0.62	90	0.15	0.23	0.27	0.40
Overland flow down St Martins Crescent	F27	Blacktown Creek	0.28	90	0.01	0.02	0.02	0.03

Location	Location	Catchment System	Catchment Area	Imperviousness	Peak Flow (m <sup>3</sup> /s)			
Piped and overland flows discharging to Blacktown Creek. Values in brackets represent surcharge flows escaping to Blacktown Mega Centre.	F28	Blacktown Creek	16.2	71	3.01	4.46	5.27	6.24
					(0.02)	(0.03)	(0.04)	(0.05)

# 3 PROPOSED DRAINAGE SYSTEM

## 3.1 GENERAL

The proposal will involve the upgrading of the existing roadway between Reservoir Road at CH 320 and approximately 160 m south of Blacktown Road at CH 2140. From approximately CH 2140 to approximately 40m south of St Martins Crescent at CH 3420 the existing road corridor is mostly paved and the works will mainly involve the conversion of the existing service road that runs along this section of the proposal to the Prospect Highway northbound carriageway. The proposal does not cross major waterways and is unlikely to have impact on existing regional flooding conditions outside of the proposal.

The new southbound carriageway will mostly be formed by resurfacing the existing sealed sections of road within the corridor. Between CH 320 and CH 2140 a new pavement will be required to form the northbound carriageway while north of CH 2140 the northbound carriageway will mostly be formed by resurfacing of the existing sealed service road and adjustment of the grassed median. The use of the existing sealed sections of road to form the new northbound carriageway means that both the vertical and horizontal alignment of the Prospect Highway will generally follow that of the existing two-lane roadway.

There are a few locations where the roadway is in superelevation resulting in runoff draining towards the median. In general, median inlet drainage pits have small uptake capacity resulting in a large number of median inlet pits at these locations. SE type kerb provides better conveyance capacity and SE type pits better uptake capacity than SF kerb and pit types. The use of SE kerb type is recommended where the road is in superelevation to minimise the number of pits required to comply with the maximum flow width. The use of alternative proprietary products such as ACO grate drains could also be investigate at a later phase of the design.

Figures 3-1 to 3-5 show the proposed concept drainage design.

## 3.2 DRAINAGE DESIGN CRITERIA

Table 3-1 below summarises the key design criteria which form the basis of the proposed drainage strategy.

**Table 3-1 Drainage Design Criteria**

Item	Criteria	Tender Brief Reference
Design Storm	Drainage Infrastructure must be designed, as a minimum, for the ARIs specified below:  Open drains (surface drains including channels, table drains, bench drains, catch drains, contour banks, drop downs, basin inflows and basin outflows) - 5 years  Piped systems (including pits) - 10 years  Pavements - nil width of flow spread onto traffic lanes – 10 years.  Cross Drainage – 100 years	Tender Brief Clause 2.2 (3)

Item	Criteria	Tender Brief Reference
Pavement Drainage	Runoff from ramps or turning roadways must not flow beyond the ramp or turning roadway noses and across the main carriageways for the 1 in 2 year ARI (Average Recurrence Interval) events.	Tender Brief Clause 2.2 (3)
	The objective for the pipe network is to be self-cleansing (self-cleansing is defined as a water velocity in the pipe of 0.6m/s for the 1 in 6 month storm event)	Tender Brief Clause 2.2 (3)
	The drainage design must separate cross drainage systems from pavement drainage systems	Tender Brief Clause 2.2 (3)
Cross Drainage	The design of cross drainage structures (pipes and box culverts) is to take consideration of staging issues (to ensure positive drainage at all times) and any special requirements for working in or realigning of creeks	Tender Brief Clause 2.2 (3)
	<p>The allowance for blockage of transverse culverts must comply with the following requirements:</p> <p>For transverse culverts with hydraulic design capacity less than or equal to 600mm diameter, or 600mm height for box culverts, the culvert size must be increased to allow for 50% capacity reduction due to blockage</p> <p>If available comply with local Council design requirements for blockage</p> <p>Must consider the site specific risk of blockage of the culverts, that is, the design must consider the likelihood of partial or full blockage based on the catchment features and the consequences of partial or full blockage on the project</p>	Tender Brief Clause 2.2 (3)
Aquaplaning	For the 50mm/hr rainfall design event, the maximum water depths on the pavement must not be more than 4mm	Tender Brief Clause 2.2 (3)
Minimum pipe sizes	The design of drainage pipes and pipe systems must use pipes with a minimum 375 mm diameter for longitudinal drainage pipes and a minimum 450 mm diameter for transverse drainage pipes.	Tender Brief Clause 2.2 (3)
Minimum Cover	The design of drainage pipes and pipe systems must provide a minimum clearance of 300 mm from the tops of pipes and box culverts to the underside of the selected material zone (SMZ).	Tender Brief Clause 2.2 (3)

### 3.3 AQUAPLANING CHECKS

Aquaplaning checks were carried out in locations where the designed longitudinal gradients are low, areas of changing road crossfall (super transitions) and at intersection.

A standard rainfall intensity of 50mm/hr was used for the calculations as specified by the Roads and Maritime. In accordance with the assessment criteria, a location is considered to be safe if the water depth on the pavement was calculated to be less than 4mm. The calculations are summarised in the table below.

**Table 3-2 Aquaplaning Checks Results**

Location	Lane	Length m	Slope S m/m	Intensity I mm/hr	Flow Depth d mm	Check if > 4mm
260	NB	39.6	0.044	50	2.0	OK
600	NB	43.1	0.039	50	2.3	OK
960	M4 Western Motorway Eastbound Exit Ramp	29.0	0.013	50	3.2	OK
1060	NB	15.0	0.006	50	3.3	OK
1240	GWH Exit Ramp Eastbound (E )	55.2	0.032	50	3.6	OK
1250	GWH Exit Ramp Eastbound (W)	82.0	0.019	50	3.6	OK
1540	SB Stoddart Road Intersection	24.9	0.044	50	1.6	OK
1940	SB	32	0.014	50	3.3	OK
2200	SB	38.4	0.012	50	3.8	OK
2640	NB	35.7	0.028	50	2.4	OK
2760	NB	42.4	0.031	50	2.6	OK
2800	SB Vesuvius Street Intersection	24.8	0.044	50	1.6	OK
2860	NB Keyworth Drive Intersection	28.7	0.064	50	1.4	OK
2970	SB	33.2	0.009	50	4.0	OK
3320	SB	49.8	0.053	50	2.1	OK

The results above indicate that the water depth does not exceed the maximum allowed depth at any location.

## 3.4 PROPOSED CROSS DRAINAGE

Four (4) cross drainage structures were identified along the corridor. Details of the existing structures are summarised in Table 2-1.

Blockage of cross drainage structures has been considered in the concept drainage design in compliance with the project brief requirements (refer to Section 3.2). The four cross drainage structures identified are located in catchments mainly comprised of residential or parkland areas. The potential of culverts to be blocked by large debris is deemed to be low.

It is proposed to extend and upgrade two of the identified cross drainage structures to provide the proposal with 100 Year ARI flood immunity. The remaining two existing culverts have adequate capacity and will be retained.

The details of the proposed changes to cross drainage structures are provided in Table 3-3.

**Table 3-3 Proposed Cross Drainage Structures**

Catchment	Design Road Chainage (Approx)	Size/Type (mm)	Upstream Invert Level (m AHD)	Downstream Invert Level (m AHD)	Adjacent Road Level (m AHD)	Proposed Treatment
Greystanes Creek	MC10 - 460	1350 RCP <sup>1</sup>	65.32	63.86	72.41	No Change
Blacktown Creek	MX01 - 110	750 RCP <sup>1</sup>	74.55	69.57	79.52	Extension of existing culverts
	MC10 - 2034	900 RCP <sup>1</sup>	64.75	63.14	70.11	No Change
	MC10 - 3100	675 RCP <sup>1</sup>	59.28	59.12	61.48	Demolish and replace existing 450 RCP with new 675 RCP

<sup>1</sup> RCP – Stands for reinforced concrete pipe.

A hydraulic assessment was undertaken to compare headwater levels upstream of the identified cross drainage structures under post upgrade conditions and existing conditions. **Figures 5-1 to 5-4 included in Appendix A** show flood extents upstream of the cross drainage structures in 100 Year ARI storm events.

Roads and Maritime propose to modify the existing pedestrian underpass located approximately at CH 1980 from a box culvert to a bridge. A sketch of the proposed bridge is included in **Appendix C** of this report. The current hydrology and hydraulic assessment indicates that the detention basin and the outlet cross drainage culvert at CH 2034 have 100 year ARI capacity and the pedestrian underpass will only operate as emergency flood route during large to extreme event (larger than 100 year ARI). Hence the modification of the pedestrian underpass is unlikely to change the flow regime in the vicinity during storm events up to 100 year ARI. Risk of flooding during construction of the bridge is also deemed to be very low.

## 3.5 NEW PAVEMENT DRAINAGE SYSTEMS STRATEGY

Runoff generated within the new and widened sections of the road will be captured and conveyed by new pavement drainage systems which will outfall to existing drainage systems located along the length of the road corridor. The new pavement drainage systems will be capable of capturing and conveying runoff generated during the 10 year ARI design storm events. Blockage of pit inlets and minimum pipe grade has been considered in the concept drainage design in compliance with the project brief (refer to Section 3.2). The concept drainage layout was developed based on the road design prepared by Roads and Maritime. Pit layout was determined using simple hydraulic calculations and complies with the flow width requirements in accordance with the project brief (refer to Section 3.2).

The strategy adopted for the development of the concept drainage design for the road upgrade consists of maintaining the existing drainage patterns as much as practical and minimise the redistribution of flows along the proposal corridor. The concept drainage design also ensures runoff from the proposal does not discharge into Prospect Reservoir.

Note that there are various locations where runoff from the existing road escapes the proposal corridor uncontrolled through the side streets. This is particularly valid for the section of the proposal located to the north of the GWH. With the proposal of the new pavement piped drainage systems to control runoff generated within the proposal corridor, the approach adopted consists of connecting the new piped systems to the existing Council's piped drainage infrastructure located within these side roads. It is noted that the Council's drainage systems are located in the vicinity of the proposal corridor in various locations and in others the connection to the Council's systems will require longer length of pipe lines to reach these drainage systems. There are locations where the available ground survey does not cover the entire extent where drainage works is required to connect to the Council's drainage systems located within the side streets. The capacity of Council's drainage system has not been assessed due to insufficient information and need to be confirmed in subsequent phases of the design.

It is recommended that the developed strategy be carried from this phase into and further confirmed in the subsequent phases of the road upgrade design. **Figures 3-1 to 3-5** presented in **Appendix A** show the layout of the proposed concept drainage design.

It is important to note that the proposed concept pavement drainage design was developed based on simple hydrologic and hydraulic calculations to determine pit locations and pipe sizes. The proposed concept drainage design will need confirmation at a later phase of the design development. Therefore, the concept drainage design layout and pipe longitudinal sections presented in **Appendix B** are indicative only.

The road alignment design has been revised after the concept drainage design was developed. The change in road alignment may lead to slight adjustment to both catchment boundaries and pavement drainage layout. However, the adjustment is deemed to be minor. Catchment boundaries and pavement drainage layout will need confirmation at a later phase of the design development.

## 3.6 IMPACT OF THE PROPOSED UPGRADE ON EXISTING DRAINAGE PATTERNS

The DRAINS model used to determine peak flows under pre-upgrade conditions was modified to reflect the changes the proposed upgrade will introduce to the surface of the proposal corridor. The new pavement drainage systems links within the DRAINS model were also altered

to reflect changes that will occur in drainage patterns as a result of the installation of new cross and pavement drainage systems along the length of the road upgrade.

The proposed concept drainage design presented on **Figures 3-1 to 3-5** forms the basis for the assessment of the potential impact of the road upgrade on the existing drainage patterns.

Table 3-4 in the next page provides an overview of the impacts the proposed road upgrade will have on the existing peak flows at the outfall locations. The table shows the comparison of peak flows under pre-upgrade and post-upgrade conditions at the outfall locations and highlights the locations where peak flows are expected to increase. Refer to the **Figures 2-1 to 2-5** and **Figures 3-1 to 3-5** in **Appendix A** for outfall locations.



Table 3-4 Peak Flow Impact Summary

Outfall ID	2 year ARI				10 year ARI				20 year ARI				100 year ARI			
	Pre Upgrade	Post Upgrade	Difference		Pre Upgrade	Post Upgrade	Difference		Pre Upgrade	Post Upgrade	Difference		Pre Upgrade	Post Upgrade	Difference	
	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(%)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(%)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(%)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(%)
F1	0.25	0.24	-0.01	-4.0%	0.39	0.37	-0.02	-5.1%	0.46	0.43	-0.03	-6.5%	0.55	0.53	-0.02	-3.6%
F2	0.03	0.04	0.01	33.3%	0.05	0.06	0.01	20.0%	0.06	0.07	0.01	16.7%	0.07	0.09	0.02	28.6%
F3	1.69	1.71	0.02	1.2%	3.12	3.12	0.00	0.0%	3.68	3.66	-0.02	-0.5%	4.69	4.68	-0.01	-0.2%
F4	1.87	1.96	0.09	4.8%	3.33	3.39	0.06	1.8%	3.92	4.1	0.18	4.6%	5.04	5.2	0.16	3.2%
F5	0.10	0.06	-0.04	-40.0%	0.27	0.26	-0.01	-3.7%	0.43	0.43	0.00	0.0%	0.92	0.89	-0.03	-3.3%
F6	0.71	0.68	-0.03	-4.2%	1.12	1.08	-0.04	-3.6%	1.32	1.27	-0.05	-3.8%	1.66	1.61	-0.05	-3.0%
F7	0.04	0.04	0.00	0.0%	0.06	0.07	0.01	16.7%	0.08	0.08	0.00	0.0%	0.09	0.1	0.01	11.1%
F8	0.44	0.45	0.01	2.3%	0.82	0.81	-0.01	-1.2%	0.96	0.96	0.00	0.0%	1.25	1.23	-0.02	-1.6%
F9	0.10	0.08	-0.02	-20.0%	0.14	0.12	-0.02	-14.3%	0.17	0.14	-0.03	-17.6%	0.21	0.18	-0.03	-14.3%
F10	0.01	0.01	0	0%	0.02	0.02	0	0%	0.02	0.02	0	0%	0.03	0.03	0	0%
F11	0.61	0.58	-0.03	-4.9%	1.09	1.00	-0.09	-8.3%	1.27	1.18	-0.09	-7.1%	1.65	1.50	-0.15	-9.1%
F12	0.568	0.72	0.04	5.9%	1.03	1.10	0.07	6.8%	1.21	1.28	0.07	5.8%	1.45	1.56	0.11	7.6%
F13	0.02	0.07	0.05	250.0%	0.02	0.1	0.08	400.0%	0.02	0.11	0.09	450.0%	0.02	0.13	0.11	550.0%
F14	0.23	0.26	0.03	13.0%	0.4	0.41	0.01	2.5%	0.48	0.48	0.00	0.0%	0.58	0.57	-0.01	-1.7%
F15	0.19	0.26	0.07	36.8%	0.25	0.4	0.15	60.0%	0.35	0.43	0.08	22.9%	0.39	0.47	0.08	20.5%
F16	0.02	0.02	0.00	0.0%	0.02	0.02	0.00	0.0%	0.08	0.08	0.00	0.0%	0.22	0.12	-0.10	-45.5%
F17	0.11	0.1	-0.01	-9.1%	0.16	0.15	-0.01	-6.3%	0.19	0.17	-0.02	-10.5%	0.22	0.21	-0.01	-4.5%
F18	0.83	0.83	0	0%	0.85	0.85	0	0%	0.86	0.86	0	0%	0.87	0.87	0	0%
F19	1.07	1.23	0.16	14.95%	1.31	1.47	0.16	12.2%	1.44	1.62	0.18	12.5%	1.73	1.86	0.13	7.51%
F20	0.62	0.69	0.07	11.3%	0.87	1.02	0.15	17.2%	0.92	1.09	0.17	18.5%	1.01	1.18	0.17	16.8%
F21	0.08	0.08	0	0%	0.12	0.12	0.00	0.0%	0.14	0.14	0.00	0.0%	0.16	0.16	0.00	0.0%
F22*	0.51 (0.01)	0.21 (0)	-0.30 (-0.01)	-58.8% (-100%)	0.75 (0.09)	0.33 (0.05)	-0.42 (-0.04)	-56% (-44.4%)	0.99 (0.12)	0.65 (0.07)	-0.34 (-0.05)	-34.3% (-41.7%)	1.30 (0.14)	1.01 (0.08)	-0.29 (-0.06)	-22.3% (-42.9%)
F23	0.09	0.15	0.06	66.7%	0.13	0.50	0.36	285%	0.15	0.56	0.41	273.3%	0.18	0.64	0.46	256%
F24	0.17	0.13	-0.04	-23.5%	0.24	0.18	-0.06	-25.0%	0.29	0.22	-0.07	-24.1%	0.34	0.27	-0.07	-20.6%
F25	0.41	0.34	-0.07	-17.1%	0.49	0.41	-0.08	-16.3%	0.50	0.46	-0.04	-8.0%	0.51	0.52	0.01	2.0%
F26	0.15	0.23	0.08	53%	0.23	0.49	0.26	113%	0.27	0.62	0.35	130%	0.39	0.78	0.39	100%
F27	0.01	0.01	0.00	0%	0.02	0.01	-0.01	-50.0%	0.02	0.02	0.00	0.0%	0.03	0.02	-0.01	-33.3%
F28	3.01	3.31	0.30	10.0%	4.46	4.66	0.20	4.5%	5.27	5.20	-0.06	-1.1%	6.24	6.38	0.14	2.2%

Peak flow unchanged or reduced under post-upgrade. Peak flow increased under post-upgrade.

\* Values in ( ) represent the flows escaping the system to the west via the Shelley Public School grounds.

A brief discussion on the expected changes and impacts on the existing drainage patterns are provided Table 3-5 below.

**Table 3-5 Discussion on Impacts of the Proposal**

Outfall ID	Catchment System	Description
F1	Greystanes Creek	The outflows at this location would be expected to reduce slightly as a result of the works associated with the proposed upgrade. The changes to Reservoir Road intersection and the proposed drainage system for this road will result in better control of runoff reducing bypass flows currently entering Reconciliation Road.
F2	Greystanes Creek	A minor increase in peak flow rate is expected due to small changes to the catchment size at the intersection of Prospect Highway and Reservoir Road. The increase is minor and is unlikely to cause adverse impact on the downstream drainage patterns.
F3	Greystanes Creek	The flows arriving at the inlet of the cross drainage structure at MC10 – 460 are expected to remain similar to the existing peak flows. The minor changes to this catchment do not have substantial impact on peak flows.
F4	Greystanes Creek	A minor increase in peak flows are expected at the outlet of cross drainage structure at MC10 – 460 due to the increase of roadway catchment discharging runoff to this location. The increase is unlikely to have substantial effect on the downstream drainage patterns.
F5	Greystanes Creek	The peak flows from C5 are expected to have a small reduction in peak flow rates due to a minor redistribution of runoff.
F6	Greystanes Creek	The peak flows from C6 are expected to have a small reduction in peak flow rates due to a minor redistribution of runoff.
F7	Blacktown Creek	A minor change to this catchment will result in negligible changes to peak runoff at the outfall.
F8	Blacktown Creek	The peak flow rates for catchment C8 are expected to remain largely the same as changes associated with the proposed upgrade will have insignificant impact on the peak flows.
F9	Greystanes Creek	The peak flow rates for catchment C9 are expected to reduce as flows bypassing the existing drainage system serving catchment C8 enter this catchment under pre-upgrade conditions. It is noted that an existing F type barrier prevents runoff from C8 from flowing to the west and re-direct the runoff to C9. The new pavement drainage system will control runoff within catchment C8 and will reduce the bypass flows arriving at the outfall of C9.
F10	Greystanes Creek	Peak flow rates are expected to remain as per pre-upgrade conditions.

Outfall ID	Catchment System	Description
F11	Blacktown Creek	<p>A small reduction in peak flow rates is expected due to a minor redistribution of runoff currently discharging to this location. The minor redistribution is related to the proposed GWH two-way ramp works. The ramp will be located in an area that currently discharges to this outfall while under post-conditions the ramp will drain to the system that discharges directly into Blacktown Creek.</p> <p>The storage provided by the drainage easement has been reduced slightly due to the proposal. Reduction of storage does not have an adverse impact on flood level due to the reduction of flow rates discharging to this location. Refer to <b>Figure 5-2</b> for pre and post upgrade flood extents during 100 Year ARI flood.</p>
F12	Blacktown Creek	<p>Minor changes introduced within catchment C11 will result in an increased area contributing with runoff to this outfall. This is largely due to the changes introduced by the proposal to the existing GWH ramp. This catchment discharges directly to Blacktown Creek at the downstream side of the GWH crossing. While peak flows discharging to Blacktown Creek north of the GWH will be increased for all storm design storms analysed, the net effect of the proposed road upgrade is considered minor in terms of changes to the total peak flow in the creek. The change is not substantial in terms of total flows and does not warrant the requirement for the provision of detention storage to mitigate the impacts.</p>
F13	Greystanes Creek	<p>Analysis of the existing drainage system serving this catchment indicates that the system is inefficient and flows bypass the system towards C15. The new pavement drainage system will be more efficient at capturing road runoff and therefore it will reduce the amount flows escaping this catchment and increase peak flow rates at the outfall. It is important to note that the proposed drainage system will connect to the existing Council pipe system at about CH 1450. This pipe system has not been located by the available survey. Assessment of the system indicates that the pipe has sufficient capacity to accommodate for the additional flows at the location of the outfall.</p>
F14	Blacktown Creek	<p>The increase in peak flows at the outfall of C14 is considered minor and unlikely to have substantial effect on downstream systems.</p>
F15	Greystanes Creek	<p>Analysis of the existing drainage system serving this catchment indicates that the system is inefficient and flows bypass the system towards C17. In addition, a small redistribution of flows will be introduced by the proposed upgrade resulting in a small reduction of catchment C17. Both C15 and C17 discharge to the same piped drainage network. Due to the magnitude of flows, the small increase is unlikely to have substantial impact on existing drainage systems and patterns.</p>
F16	Blacktown Creek	<p>A small reduction in peak flow rates is expected due to a minor redistribution of runoff currently discharging to this location.</p>
F17	Greystanes Creek	<p>The peak flows at this location is expected to reduce due to a small change to the catchment discharging to this outfall.</p>

Outfall ID	Catchment System	Description
F18	Blacktown Creek	<p>This catchment discharges to a Council detention storage area. The proposed drainage system will not introduce peak flow changes entering this storage area. No substantial changes are expected for this location.</p> <p>It is important to note that the proposal does not impact on the existing detention storage basin. Modification of the existing pedestrian underpass within this area will not change flow regime during storm up to 100 year ARI.</p>
F19	Blacktown Creek	<p>A small increase in peak flows is expected at this location largely due to the increase in paved surface within the catchment. The proposed drainage system will discharge to a Council detention storage area located at about CH 2040. Given the sensitivity of this location and potential impacts of additional flows discharging to the detention storage, it is recommended additional storage is provided to mitigate the potential impacts. A preliminary estimate indicates that 300 m<sup>3</sup> is required storage to accommodate for the increase in peak flows. The additional storage can be easily accommodated within the existing detention storage area. A preliminary sketch of the earthworks and extent of the works is provided in <b>Appendix B</b>. It should be noted that the preliminary design of the earthworks assumed a 4H:1V batters for easy maintenance (i.e. mowing) of the area.</p>
F20	Blacktown Creek	<p>Analysis of the existing drainage systems within C20 indicates that flows bypass the drainage system within this catchment towards C22. The proposed drainage system will be more efficient at capturing runoff and will reduce bypass flows resulting in increase of peak flows at the outlet of this catchment.</p>
F21	Blacktown Creek	<p>Peak flows will remain largely the same under post-upgrade conditions.</p>
F22	Greystanes Creek/ Blacktown Creek	<p>The total peak flows discharging from this catchment is expected to substantially reduce. The outfall is located within a low point and existing piped drainage system does not have sufficient capacity to convey the design flows for most design storm events (refer discussion in Section 2.2). A surcharge system is proposed by concept drainage design to re-direct surcharge flows through Vesuvius Street. The surcharge system will be comprised of a two chamber drainage pit located at the low point. The low flows will discharge to the existing pipe system located at the low point while excess flows will surcharge into the second chamber connected to a drainage pipe that will run along Prospect Highway and connect to the Vesuvius Street drainage system. This arrangement will reduce nuisance flooding at the property located opposite the low point (No. 223/223A Prospect Highway).</p>

Outfall ID	Catchment System	Description
F23	Greystanes Creek	Additional flows will enter C23 from C22 as part of the proposed concept drainage design and result in substantial increase in peak flows entering Vesuvius Street from Prospect Highway. However, it should be noted that the re-directed flows would end up in Vesuvius Street via Everest Street under the pre-upgrade conditions and flow to the drainage system located within the low point in Vesuvius Street (opposite No. 15 Vesuvius Street). A simple analysis of the total flows discharging to the low point in Vesuvius Street indicates that the proposed arrangement will not have substantial impact on the total peak flows at this location. It is recommended, however, that further analysis is undertaken to confirm this finding and confirm that the proposal in this vicinity does not adversely impact on the surroundings.
F24	Blacktown Creek	The peak flows at this location is expected to reduce due to a small change to the catchment discharging to this outfall.
F25	Blacktown Creek	Minor changes to peak discharges are expected as part of the proposal. The changes are unlikely to result in adverse impact on the existing drainage patterns downstream of the outfall.
F26	Blacktown Creek	The total flows discharging at the outfall of C26 accounts for the surcharge/bypass flows from C25. Peak flows are expected to increase as the current detention storage provided within Roads and Maritime land (marked as future road corridor land) on the eastern side of the Prospect Highway at CH 3100 will be removed and result in increased bypass flows from C25 discharging to C26. The removal of this storage is mainly responsible for the increased flows discharging via Tudor Avenue to Blacktown Creek. Roads and Maritime has advised that no storage should be accommodated within the future corridor land.
F27	Blacktown Creek	Peak flows will remain largely the same under post-upgrade conditions.
F28	Blacktown Creek	A small redistribution of flows will result in an increase of peak flows will discharging this catchment. Additional flows will generally be contained within the roadway and discharge to Blacktown Creek located about 300m north of the limits of works.

## 3.7 RECOMMENDED DRAINAGE STRATEGY

The recommended drainage strategy discussed below is based on the concept drainage design presented in **Figures 3-1 to 3-5**. This section should be read in conjunction with these figures.

The recommendations provided below were developed based on available and current information. They are deemed correct for this stage of the design. However, it is important to note that the recommendations should be confirmed in the subsequent phases of the design as more information becomes available and the design of the proposal changes and progresses.

### Catchment C1

- Construct new pavement drainage lines along western kerblines of Reconciliation Road and connect to the existing pavement drainage system.
- Demolish and remove a short section of existing piped drainage system serving median of Reconciliation Road in the vicinity of the intersection with Reservoir Road and replace with new pavement drainage line to suit the proposed works.
- Construct new catch drain along the western edge of Reconciliation Road proposed works to replace existing catch drain running through this section which will be impacted by proposal.

### Catchment C2

- No drainage works are proposed within this catchment other than adjustments to kerblines to connect to existing kerblines and drainage channels in Reservoir Road (East) and Thornley Road.

### Catchment C3

- Construct new pavement drainage system along northern kerblines of Reservoir Road and western kerblines of Prospect Highway between CH 330 and CH 420 and between CH 460 and CH 670. Connect new pavement drainage system to inlet of the existing 1350 mm diameter cross drainage culvert at CH 460.
- Construct new pavement drainage system along western kerblines of Prospect Highway between CH 700 and CH 810. An open drain is proposed along the back of the shared path to intercept and convey flows from cutting and to avoid an excessive number of inlet pits along the kerblines. It will also prevent runoff from flowing across the shared path. It is recommended that the shared path is graded to the proposed open drain.
- Connect existing catch drain to new pavement drainage system at about CH 810.
- Demolish and remove existing 375 mm diameter pipe across M4 Western Motorway westbound entry ramp and replace with a new 450 mm diameter pipe.

### Catchment C4

- Construct new pavement drainage system along eastern kerblines of Prospect Highway between CH 360 and CH 620. New pavement drainage system is to discharge to eastern side of Prospect Highway in the vicinity of the outlet of existing 1350 mm diameter cross drainage culvert at CH 460.
- Retain existing pavement drainage system located along eastern kerblines of Prospect Highway between CH 620 and CH 720.

### **Catchment C5**

- Retain existing pavement drainage system located along southern kerblines of M4 Western Motorway westbound exit ramp.
- Construct new pavement drainage system to serve proposed traffic island and connect to existing drainage system.

### **Catchment C6**

- Construct new pavement drainage system on the eastern kerblines of Prospect Highway at around CH 760 and connect to existing M4 Western Motorway detention basin.
- Retain existing drainage system in the vicinity of CH 870.
- Demolish and remove existing drainage system between CH 880 and CH 980 and replace with new pavement drainage systems along both western and eastern kerblines. Connect new pavement drainage systems to existing open channel located along eastern side of the Prospect Highway.

### **Catchment C7**

- No drainage works is proposed within this catchment other than adjusts to kerblines to connect to existing kerblines gutter within M4 eastbound offramp.

### **Catchment C8**

- Demolish and remove existing drainage system between CH 1020 and CH 1120 and replace with new pavement drainage system along western kerblines. Connect new pavement drainage system to existing open channel on the western side of Prospect Highway running to existing GWH 750 mm diameter cross drainage pipe.

### **Catchment C9**

- Construct new pavement drainage system along eastern kerblines and connect new drainage system to existing open channel located on eastern side of the existing bridge over the Great Western Highway.

### **Catchment C10**

- No drainage works is proposed within this catchment other than adjusts to kerblines to connect to existing kerblines and gutter within GWH eastbound entry ramp.

### **Catchment C11**

- Extend existing 750 mm diameter pipe to suit proposed GWH two-way ramp. Refer to Table 3-3
- Construct new pavement drainage system and connect to existing drainage system located on the northern side of proposed GWH two-way ramp.

### **Catchment C12**

- Construct new inlet pit within the GWH median and connect to existing drainage system.
- Demolish and remove existing GWH eastbound carriageway and exit ramp drainage system within this vicinity and replace with new pavement drainage system. Connect existing drainage system serving GWH westbound carriageway and median to new pavement drainage system.

- Connect new pavement drainage system to a new open drain to run along the northern side of the GWH towards Blacktown Creek.

#### **Catchment C13**

- Construct pavement drainage system along eastern kerblines of Prospect Highway and connect to existing piped drainage system located at around CH 1450.

#### **Catchment C14**

- Construct a new open drain along western edge of proposed works. Discharge is to be collected by new drainage system (median pits and 375mm diameter pipe and connect to existing piped drainage system).
- Construct pavement drainage systems along western kerblines of Prospect Highway and connect to new open drain.

#### **Catchment C15**

- Construct new pavement drainage systems along both western and eastern kerblines of Prospect Highway between CH 1460 and CH 1660.
- Connect new pavement drainage systems to existing piped drainage system located on eastern side of Prospect Highway at around CH 1620.

#### **Catchment C16**

- No drainage works is proposed within this catchment other than adjust to kerblines to connect to existing kerblines within Harrod Street.

#### **Catchment C17**

- Demolish and remove existing piped drainage system and replace with new pavement drainage systems along both western and eastern kerblines of Prospect Highway between CH 1680 and CH 1720.
- Construct new catch drain along the western edge of the roadway between CH 1700 and 1790 and connect to new pavement drainage system.

#### **Catchment C18**

- Retain the existing detention basin on the eastern side of Prospect Highway. Blacktown City Council has advised that the parcel of land adjacent to the basin is used as a privately operated on-site detention basin. No additional information is available to confirm its availability or performance as an overflow basin
- Modification of earthworks to detention basin on the western side of Prospect Highway to provide additional stormwater storage of approximately 300 m<sup>3</sup>.
- Retain existing cross drainage and piped drainage systems within this catchment.
- Construct new pavement drainage system along eastern kerblines of Prospect Highway between CH 1740 and CH 1960 and connect to existing underground drainage system located to the north of existing pedestrian underpass at CH 1980. The connection pass the existing pedestrian underpass is to avoid potential surcharge to flow into the underpass.

#### **Catchment C19**



- Construct a new open drain along western edge of roadway between CH 1990 and CH 2100 and connect to existing Council detention basin in this vicinity.
- Construct new pavement drainage systems along eastern and median kerblines of Prospect Highway between CH 1720 and CH 2110 and connect to new open drain.
- Construct new earthworks within existing detention basin to provide an additional storage of around 300 m<sup>3</sup> to accommodate additional runoff discharging to this basin.

#### **Catchment C20**

- Retain existing piped drainage system located within the vicinity of CH 2300 Prospect Highway.
- Construct a new pavement drainage system along western, median and eastern kerblines of Prospect Highway and connect to existing piped drainage system at around CH 2280.

#### **Catchment C21**

- No drainage works is proposed within this catchment.

#### **Catchment C22**

- Demolish and remove existing piped drainage system and replace with new pavement drainage systems along both western and eastern kerblines of Prospect Highway between CH 2500 and CH 2600.
- Construct a new surcharge pit system at low point at around CH 2600 to convey surcharge flows in excess of the 10 year ARI design storm event to catchment C23. Connect surcharge pit system to new pavement drainage system to serve C23.

#### **Catchment C23**

- Construct new pavement drainage systems along both eastern and median kerblines of Prospect Highway between CH 2600 and CH 2800.
- Connect new pavement drainage system to existing drainage system at Vesuvius Street near intersection with Everest Street.
- Undertake further assessment accounting for existing Council's piped drainage network located within residential catchment discharging to low point in Vesuvius Street to confirm the effects of the proposal on the existing drainage patterns within this vicinity.

#### **Catchment C24**

- Construct new pavement drainage systems along western kerblines of Prospect Highway between CH 2780 and CH 2860.
- Connect new pavement drainage system to existing drainage system at Keyworth Drive near intersection with Beaufort Road.

#### **Catchment C25**

- Replace existing cross drainage system at CH 3100 with a new 675 mm diameter pipe and connect to existing drainage system on the western side of Prospect Highway. Refer to Table 3-3
- Replace existing piped drainage system and replace with new pavement drainage systems along eastern, western and median kerblines of Prospect Highway between CH 2840 and CH 3140.

- Connect new pavement drainage systems to proposed cross drainage pipe at CH 3100.
- Construct a new surcharge pit system on the western kerb of Prospect Highway at around CH 3100 to convey surcharge flows in excess of the 10 year ARI design storm event to catchment C26. Connect surcharge pit system to new pavement drainage system to serve C26. New pavement drainage system is sized to limit surcharge flow on Prospect Highway in storm events greater than 10 year ARI. The drainage line linking the surcharge pit to Tudor Ave was sized to limit the flow widths within the road shoulder for up to 100 year ARI.

#### **Catchment C26**

- Construct a new pavement drainage system western kerblines of Prospect Highway between CH 3100 and CH 3320.
- Connect new pavement drainage system to existing drainage system at Tudor Avenue near intersection with Beaufort Road.
- Undertake further assessment to confirm the capacity of the existing drainage systems and to confirm the effects of the proposal on the existing drainage patterns within this vicinity.

#### **Catchment C27**

- No drainage works is proposed within this catchment.

#### **Catchment C28**

- Construct new pavement drainage system along eastern kerblines of Prospect Highway.
- Demolish and remove a short section of existing piped drainage system across Roger Place roadway and replace with new pavement drainage line.
- Construct new pavement drainage lines along eastern and median kerblines between CH 3240 and CH 3460.
- Upgrade existing pavement drainage system along eastern kerblines between CH 3460 and CH 3600.
- Upgrade existing pavement drainage from 1050 mm diameter pipe to twin 1200 mm diameter pipes from CH 3600 and continues to discharge into Blacktown Creek
- Construct new inlets and 1050 mm diameter pipe at Cat Place and connect to new pavement drainage line to minimise overland runoff from Cat Place. The new 1050 diameter pipe is to follow the existing pathway (at CH 3600) between Cat Place and the Prospect Highway. Further survey information of Cat Place and the pathway is required to confirm this proposed strategy.

## 4 EROSION AND SEDIMENT CONTROL

Water quality in downstream drainage lines and watercourses is expected to be impacted upon during the construction phase of this proposed upgrade. To mitigate these impacts, a strategy was developed involving appropriate measures.

A layout of the recommended erosion and sediment control strategy is provided in **Figures 4-1 to 4-5**.

The likelihood for erosion and sediment mobilisation during construction has been considered at various locations within the construction corridor throughout the section of upgrade. This erosion and the associated potential for sediment to be transported to downstream watercourses have been addressed in the development of this strategy.

It is recommended that this proposed strategy be used in the preparation of the Soil and Water Management Plan required as part of the final design. However it is important to note that the final requirements for erosion and sediment control during the construction process will be affected by the final design of the upgrade works and involves consideration of proposed construction methods and staging practices which are yet to be finalised.

This strategy has been developed based on design guidelines set out in the Soils and Construction – Managing Urban Stormwater, Volume 1 (Landcom, 2004) , also known as the 'Blue Book'.

In the development of the erosion and sediment control strategy, it has been assumed that local erosion and control measures during construction will be sufficient for the sections of the upgrade where the existing road corridor is mostly paved and the works will mainly involve the conversion of the existing roadway to form the southbound carriageway and where the conversion of the existing service roads north of Lancelot Street will form the northbound carriageway.

### 4.1 KEY ELEMENTS OF PROPOSED STRATEGY

Effective erosion and sediment control primarily aims to minimise erosion and then capture and remove sediment from disturbed areas where erosion is unavoidable.

In addition to sediment capture measures presented as part of this proposed strategy, erosion control methods need to be incorporated into the development of the Soil and Water Management Plan.

#### **Local erosion and sediment control measures**

In assessing the appropriate measures to be taken at various locations along the upgrade, the Blue Book was consulted and the Revised Universal Soil Loss Equation (RUSLE) was applied in determining whether or not sediment retention basins were required. In locations where soil loss calculated using the RUSLE was over 150 m<sup>3</sup>/yr, sediment retention basins were required by the Blue Book.

A proposed construction staging plan was prepared by Roads and Maritime and was used to determine the extent of the disturbed catchments and identify the potential locations for sediment retention basins.

The table below shows the parameters that remained constant in the application of the RUSLE for each catchment in the upgrade.

**Table 4-6 Constant Parameters (RUSLE)**

Parameter	Value	Comment
Rainfall Intensity for 2 year ARI, 6 hour duration design storm	10.6mm/hr	From IFD Data provided for Prospect Region
Rainfall Erosivity Factor (R)	2450	Calculated using Equation 2 in Appendix A2 of Blue Book, based on 2 year ARI, 6 hour design duration storm
Sediment Type	D	Blacktown Soil Landscape
Soil Erodibility Factor (K)	0.038	Table C20 from Appendix C in Blue Book
Erosion Control Practice Factor (P)	1.3	Representative of compacted and smooth surface conditions on site. Taken from Table A2 in Appendix A of Blue Book
Cover Factor (C)	1.0	Representative of bare earth conditions on site

The table below shows the derivation of Annual Average Soil Loss for the sections along the proposal corridor likely to be disturbed by the proposed works. There are a couple of locations where sediment loads were estimated to just below 150 m<sup>3</sup>/yr. These are located at around CH 700 and CH 1540. At this stage of the design, sediment basins are not required at these locations but these should be reviewed depending on the final design of the proposed works and construction methods and staging. It is assumed that local sediment control measures will suffice at all locations.

**Table 4-2 Approximate Annual Average Soil Loss**

Erosion Control Area (ECA)	Site area	Disturbed catchment area (ha)	Estimated Soil Loss (ESL) (m <sup>3</sup> /yr)
<b>ECA1</b>	<b>CH 160 - CH 310 W</b>	0.345	49
<b>ECA2</b>	<b>CH 350 – CH 700 W</b>	0.378	12
<b>ECA3</b>	<b>CH 710 – CH 820 W</b>	0.368	148
<b>ECA4</b>	<b>CH 860 – CH 940 W</b>	0.167	46
<b>ECA5</b>	<b>CH 940 – CH 960 W</b>	0.027	1
<b>ECA6</b>	<b>CH 1010 - CH 1160 W</b>	0.359	49

Erosion Control Area (ECA)	Site area	Disturbed catchment area (ha)	Estimated Soil Loss (ESL)
			(m <sup>3</sup> /yr)
ECA7	CH 1190 (GWH median – 1)	0.151	3
ECA8	CH 1190 (GWH median – 2)	0.303	8
ECA9	CH 1220 – CH 1260 W	0.054	9
ECA10	CH 1230 (GWH ramp - 1)	0.218	58
ECA11	CH1230 (GWH ramp - 2)	0.328	29
ECA12	CH 1230 (GWH ramp - 3)	0.408	63
ECA13	CH 1230 – CH 1580 W	0.613	146
ECA14	CH 1580 – CH 1660 W	0.152	3
ECA15	CH 1690 – CH 1715 W	0.025	1
ECA16	CH 1715 – CH 1810 W	0.127	7
ECA17	CH 1810 – CH 1970 W	0.288	40
ECA18	CH 1970 – CH 2030 W	0.096	21
ECA19	CH 2030 - CH2300	0.359	101

## 5 CONSTRUCTABILITY

Key constructability issues identified during development of the concept drainage design include the following:

- Construction of new pavement drainage on existing road corridor. Design needs to take consideration of minimising interference to existing traffic flow on Prospect Highway and providing construction staging to construct the new pavement drainage as safe as possible for all concerned.
- Construction of new pavement drainage near existing utilities corridor. Utilities survey is incomplete and elevations of certain utilities are missing. Check for clashes between new pavement drainage and existing utilities have been undertaken using available information only. Further survey information is required for levels of existing utilities. The design needs to take considerations of avoiding clashes with utilities and consider the proposed relocation of the utilities.
- Trenching for the construction of stormwater drainage lines in the vicinity of the telegraph poles will need to consider the support of the poles.
- Upgrade of pavement drainage near the intersection of Prospect Highway and Bungarribee Road. This includes construction of twin 1200mm diameter pipes within limited space to avoid clash with utilities. The design needs to take consideration of minimising relocation of utilities and avoiding clashes with utilities. The relocation of the existing underground electrical cables cannot be avoided and will need to be undertaken to make space/ avoid clash with the proposed twin 1200 mm diameter pipes.

Further to the above, Roads and Maritime has undertaken a constructability workshop in August 2013. The details of the workshop were documented in the Constructability Review Report prepared by Roads and Maritime.

## 6 OUTSTANDING ISSUES

- Results of additional survey of utilities which have insufficient 3d information to confirm pavement drainage systems are not clashing with utilities
- Further information on Council's drainage system to undertake hydraulic capacity assessment. This is required where proposed drainage work is required to connect to the Council drainage system.
- Further survey information of Cat Place and adjacent pathway to confirm proposed drainage strategy in this area.

## 7 SUMMARY

A drainage investigation was undertaken to determine the existing drainage patterns within the proposal's corridor and to determine the impacts the upgrade of the Prospect Highway will have on these drainage patterns. The pre-upgrade peak flows were estimated at locations where runoff outfalls along the road corridor. The estimated pre-upgrade peak flows also provided a basis for comparison with the peak discharges from the road corridor under post-upgrade conditions. **Figures 2-1 to 2-5** show the pre-upgrade catchment plan used for the assessment of existing conditions peak flows.

The proposed concept drainage design presented on **Figures 3-1 to 3-5** forms the basis for the assessment to determine peak flows under post-upgrade conditions. The post-upgrade peak flows were compared with the pre-upgrade flows to identify the locations where the proposed upgrade will impact on the existing drainage patterns. The table under **Section 3.4** of this report presents the results of this analysis. The assessment determined that the proposal will introduce changes to the existing drainage patterns at numerous locations. Measures are proposed for locations where the changes were considered significant to minimise the effect of the proposal on the drainage patterns. The proposed strategy and findings of current assessment will need to be confirmed as the design of the upgrade progresses in the next phases.

The concept drainage design proposes to connect the new pavement drainage systems to Council's drainage systems located within the side roads. The capacity of these systems will need to be confirmed at a later phase of the proposal.

**Annual Average Soil Loss**

The average amount of soil lost in a location per year.

**Antecedent Moisture Condition**

The word antecedent simply means 'preceding' and so the AMC refers to the relative wetness or dryness of a drainage basin before a rainfall event or other leading to water flow through the area.

**Aquaplaning**

Aquaplaning by the tyres of a vehicle occurs when a layer of water builds between the wheels of the vehicle and the road surface which leads to a loss of traction and of control. Traction is still diminished even without aquaplaning in wet conditions.

**Australian Height Datum (AHD)**

A common national surface level datum approximately corresponding to mean sea level.

**Average Recurrence Interval (ARI)**

The long-term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. **Cadastral, cadastral base** Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.

**Batter**

A slope, as of the outer face of a wall, that recedes from bottom to top.

**Basin**

A storage site (such as a small reservoir) that delays the flow of water downstream

**Cadastral information**

A map or survey showing or recording property boundaries, subdivision lines, buildings, and related details.

**Catchment**

The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.

**Cross drainage**

A cross drainage work is a structure carrying the discharge from one stream across another that intercepts it

**Cross fall**

The transverse sloping of a roadway toward the shoulder or gutter on either side

**Cross pipe**

A pipe that provides a convergence or cross over between two other pipes.

**Culvert**

A culvert is a structure that allows water to flow under a road, railroad, trail, or similar obstruction.



**Design storm/flood**

A significant event to be considered in the design process; various works within the floodplain may have different design events. e.g. some roads may be designed to be overtopped in the 1 in 1 year ARI.

**Discharge**

The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.

**Drainage easement**

A drainage easement is a legal addition to a property deed that allows a certain party to access part of a property for drainage

**Embankment**

In transportation, a raised bank to carry a road, railway, or canal across a low-lying or wet area

**Hydraulics**

The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.

**Hydrology**

The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.

**Inflow**

Something, such as a liquid or gas, that flows in

**Inundation**

From inundate, To cover with water, especially floodwaters.

**Invert**

The bottom of the inside of a pipe.

**Low point**

The point of lowest elevation above AHD

**On grade**

At ground level. Supported directly on the ground.

**Mathematical/computer models**

The mathematical representation of the physical processes involved in runoff and stream flow. These models are often run on computers due to the complexity of the mathematical relationships. In this report, the models referred to are mainly involved with rainfall, runoff, pipe and overland stream flow.

**Peak discharge**

The maximum discharge occurring during a storm/flood event.

**RCP**

Reinforced Concrete Pipe

**RCBC**

Reinforced Concrete Box Culvert

**Runoff**

The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.

**RSG Pits**

Raised Steel Grate Pit. Refer To RMS Model Drawing MD.R11.B37.A.2

**SA1 Pits**

Gully Pit Type SA. Refer to RMS Model Drawing MD.R11.B02.A.1

**SA2 Pits**

Gully Pit Type SA. Refer to RMS Model Drawing MD.R11.B02.A.1

**SE Pits**

Gully Pit Type SE. Refer to RMS Model Drawing MD.R11.B06.A.1

**SO Pits**

Gully Pit Type SO1 and SO2. Refer to RMS Model Drawing MD.R11.B21.A.1 and MD.R11.B22.A.1

**Sediment mobilisation**

The movement of loose soils and sediments

**Spillway**

A spillway is a structure used to provide the controlled release of flows from a dam or levee into a downstream area

**Super elevation** Super elevation is tilting the roadway to help offset centripetal forces developed as the vehicle goes around a curve.

**Surcharge**

An additional or excessive burden; an overload.

**Topography**

A surface which defines the ground level of a chosen area.

**Verge**

A narrow strip of grass or plants located between the carriageway curb and the boundary

APPENDIX A

FIGURES







FIGURE 1 - LOCALITY

1:10,000 @ A3  
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North Sydney NSW 2060







FIGURE 2-1 - PRE-UPGRADE CATCHMENT PLAN (SHEET 1 of 5)

1:2,750 @ A3

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FIGURE 2-2 - PRE-UPGRADE CATCHMENT PLAN (SHEET 2 of 5)

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FIGURE 2-3 - PRE-UPGRADE CATCHMENT PLAN (SHEET 3 of 5)

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FIGURE 2-4 - PRE-UPGRADE CATCHMENT PLAN (SHEET 4 of 5)

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FIGURE 2-5 - PRE-UPGRADE CATCHMENT PLAN (SHEET 5 of 5)



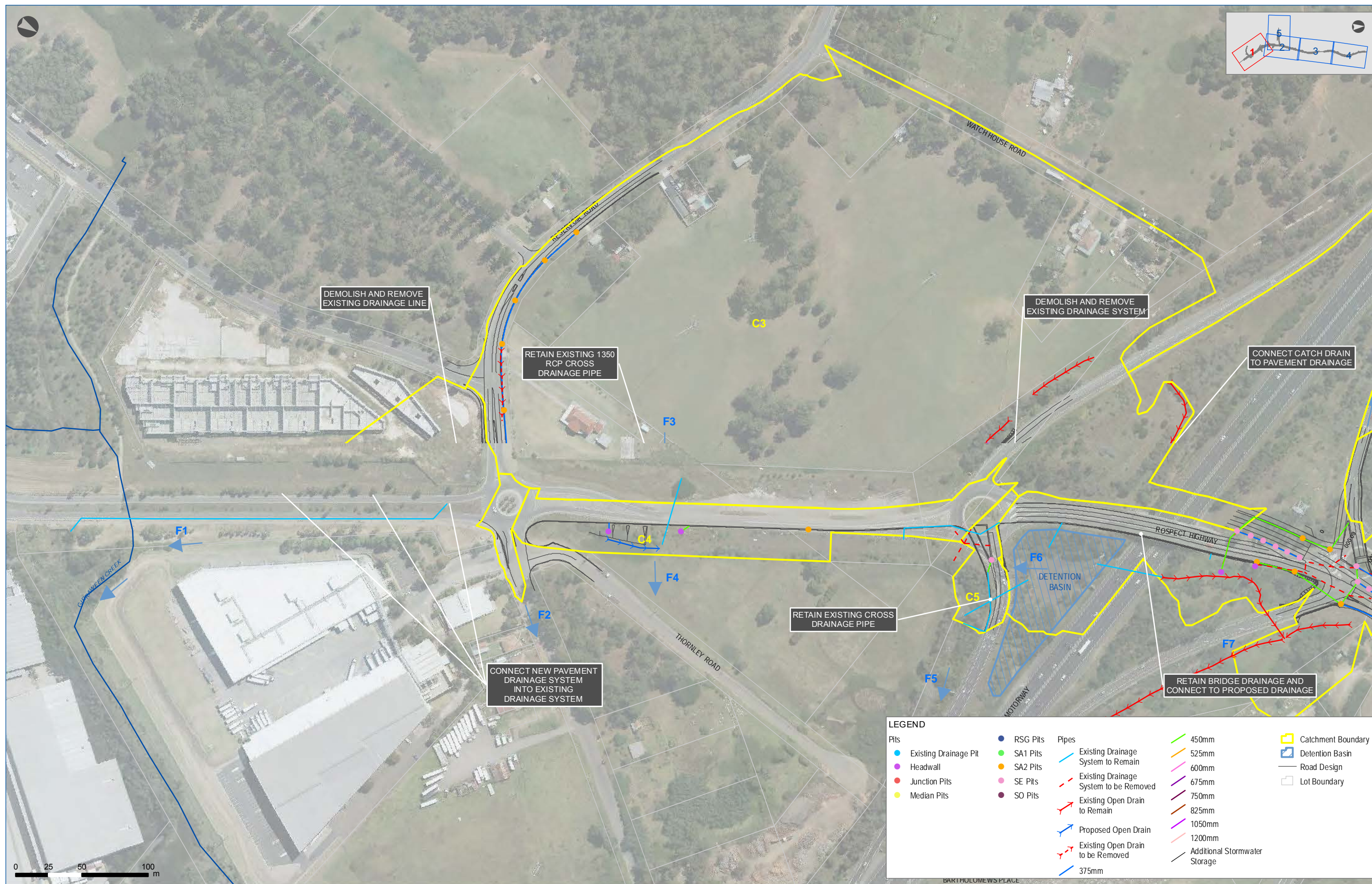


FIGURE 3-1 - CONCEPT DRAINAGE DESIGN (SHEET 1 of 5)

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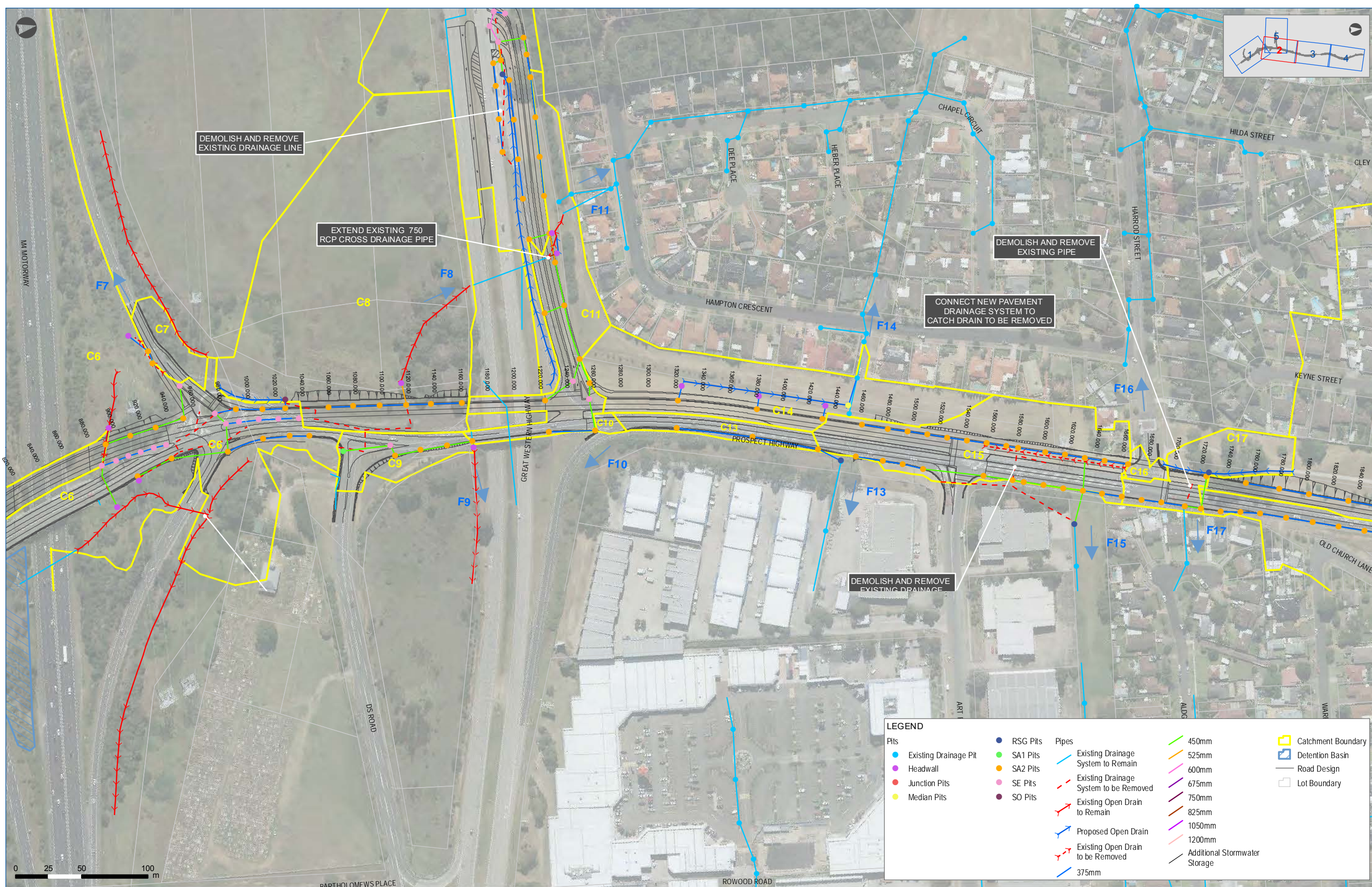


FIGURE 3-2 - CONCEPT DRAINAGE DESIGN (SHEET 2 of 5)

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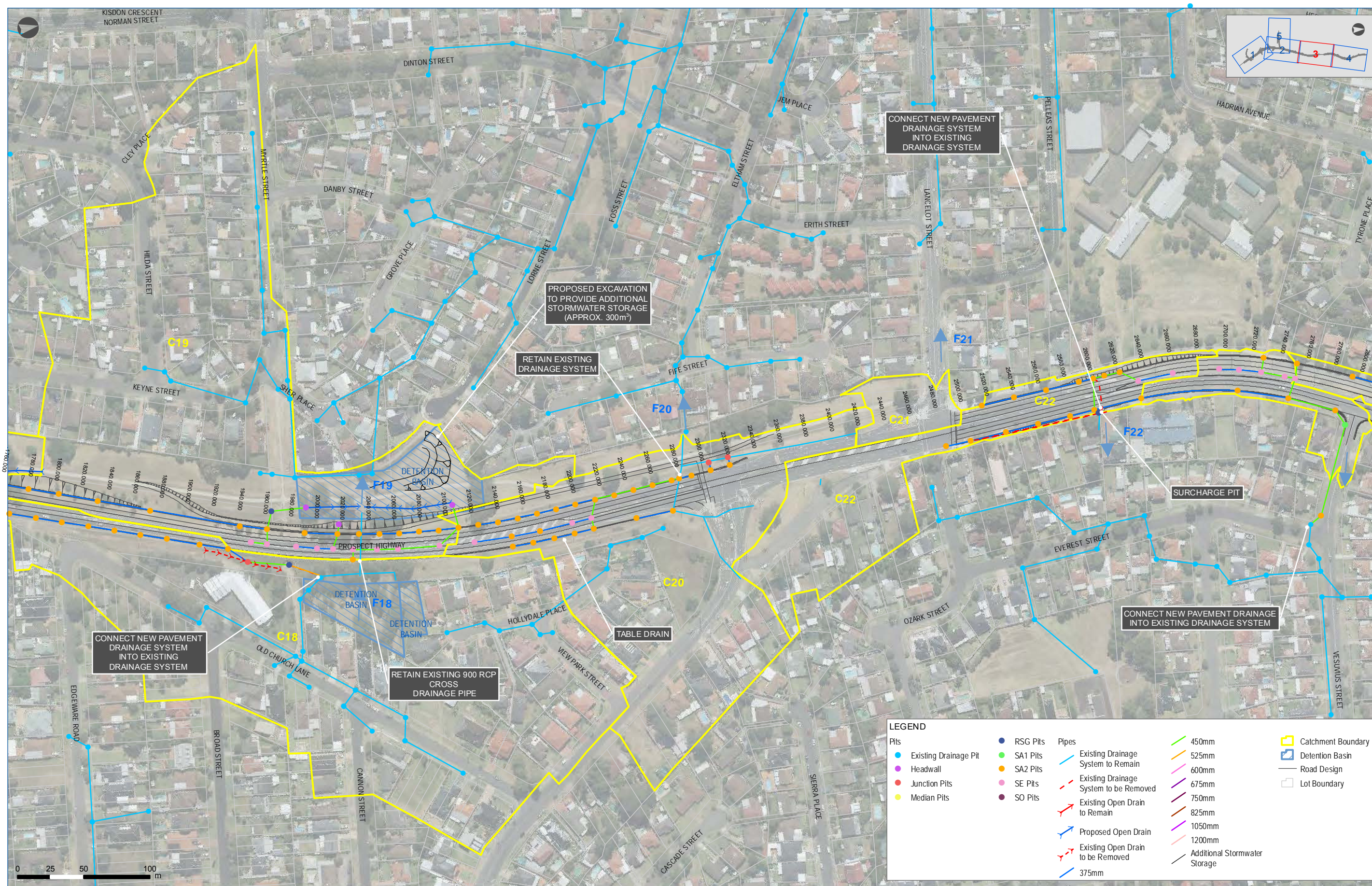


FIGURE 3-3 - CONCEPT DRAINAGE DESIGN (SHEET 3 of 5)

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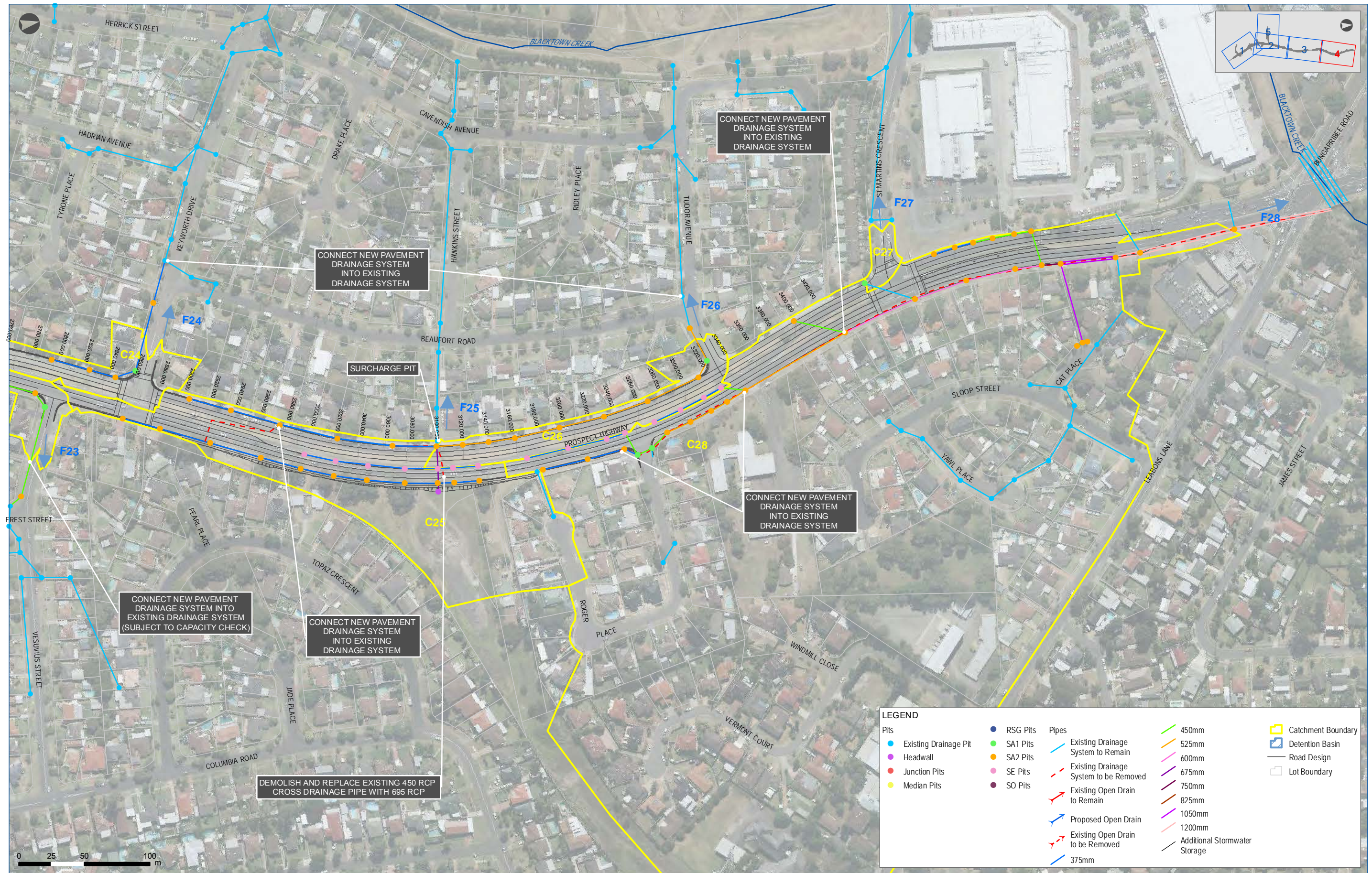


FIGURE 3-4 - CONCEPT DRAINAGE DESIGN (SHEET 4 of 5)

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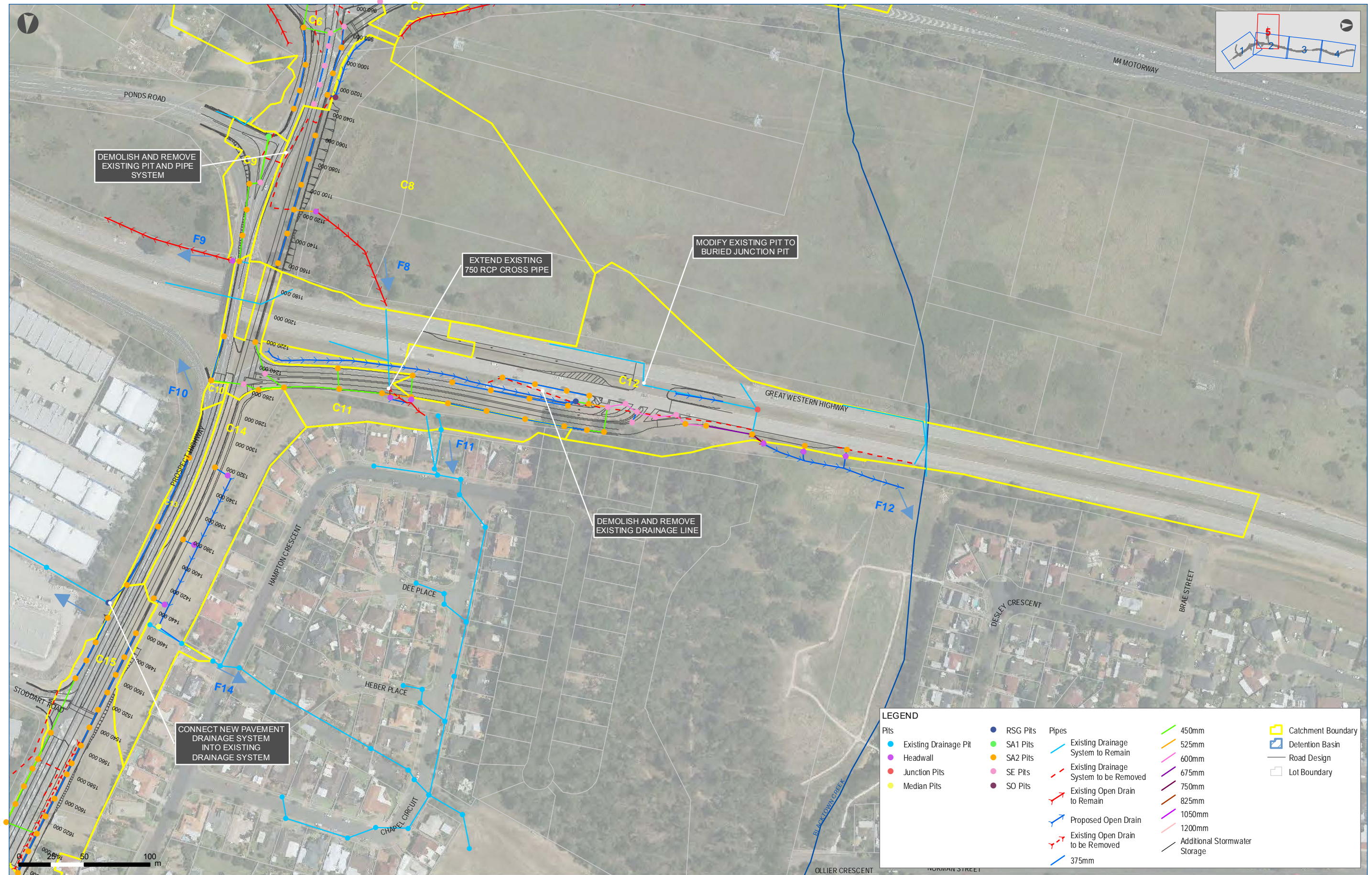


FIGURE 3-5 - CONCEPT DRAINAGE DESIGN (SHEET 5 of 5)

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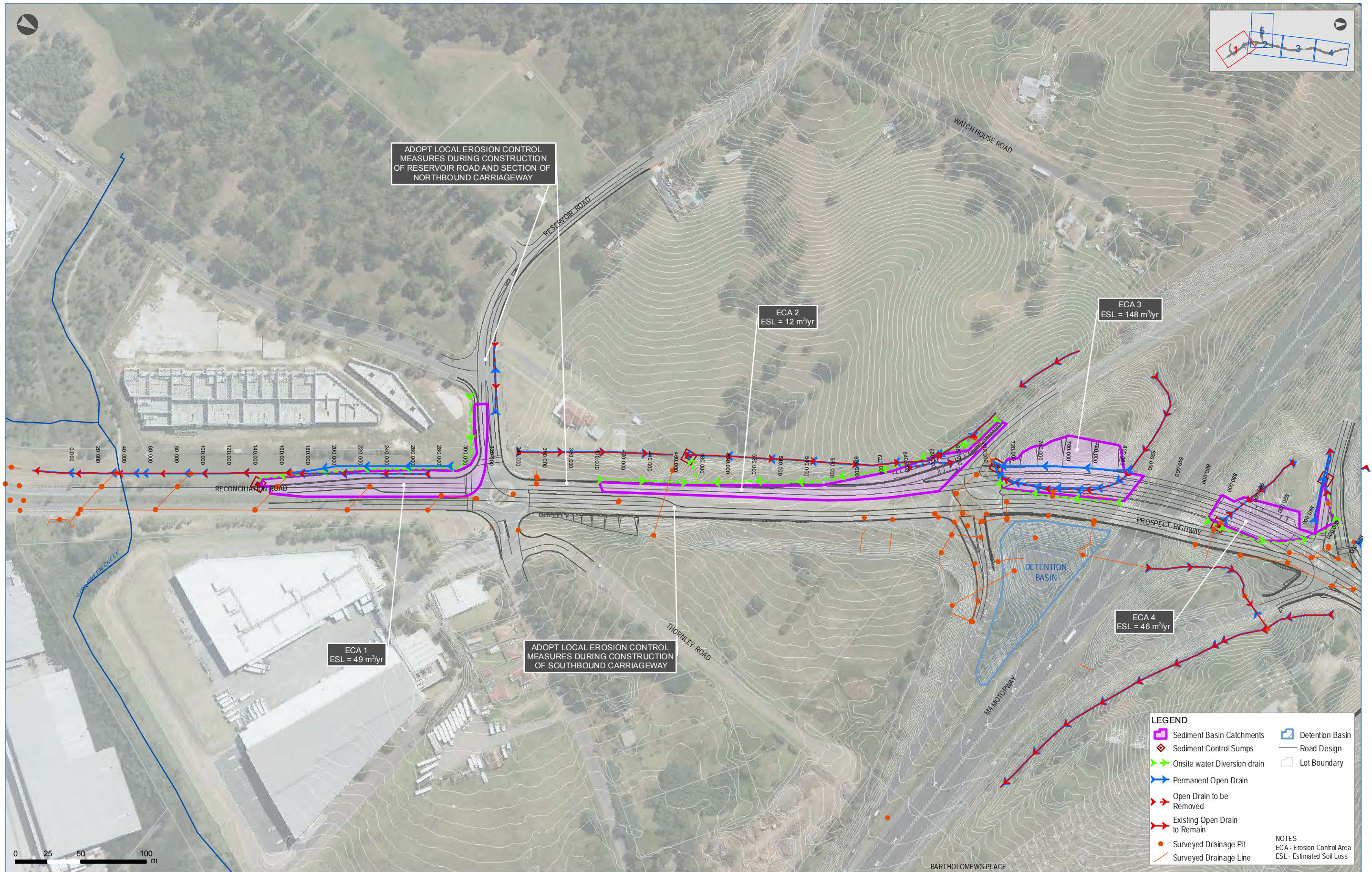


FIGURE 4-1 - EROSION AND SEDIMENT CONTROL (SHEET 1 of 5)

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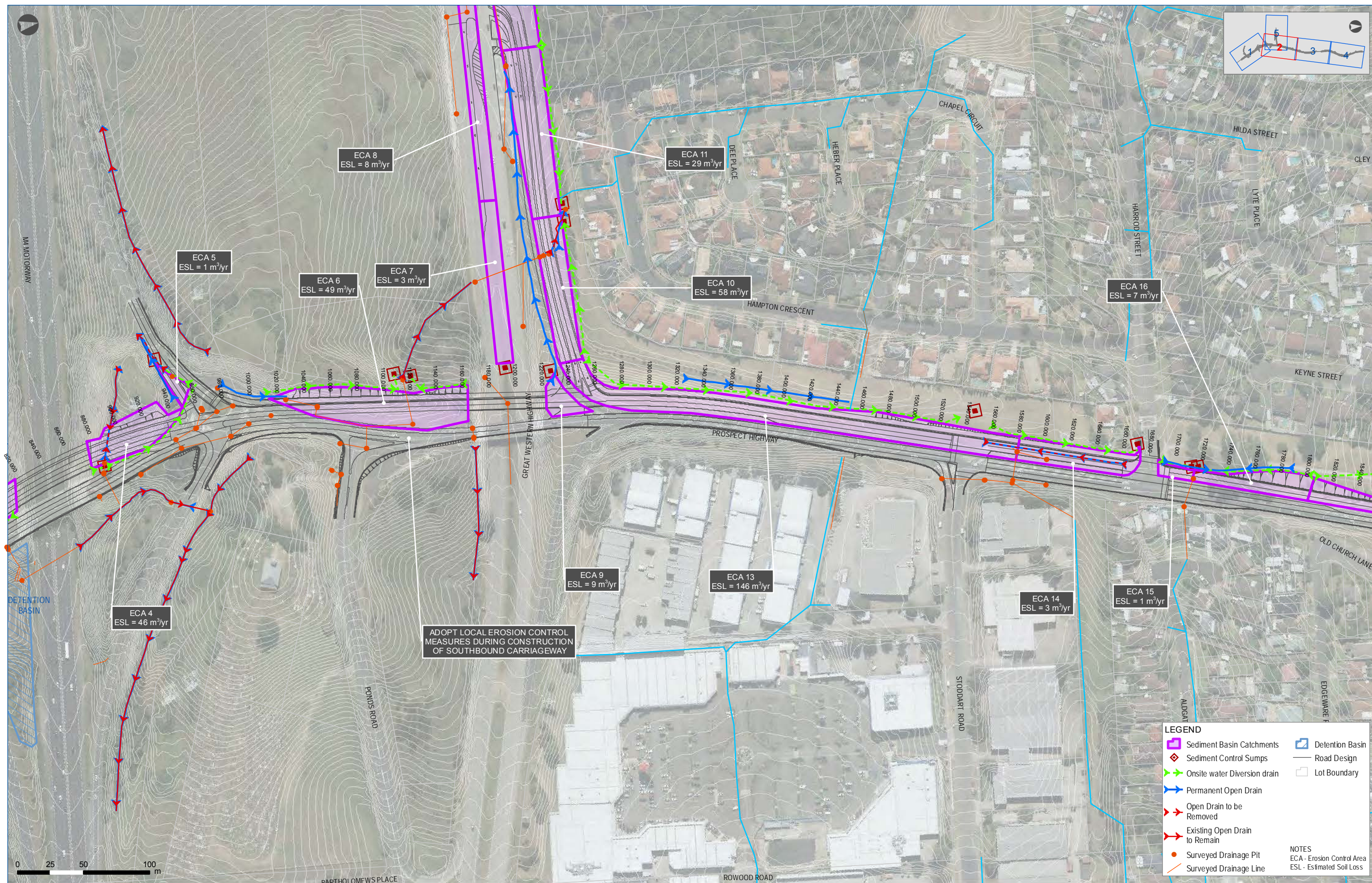


FIGURE 4-2 - EROSION AND SEDIMENT CONTROL (SHEET 2 of 5)

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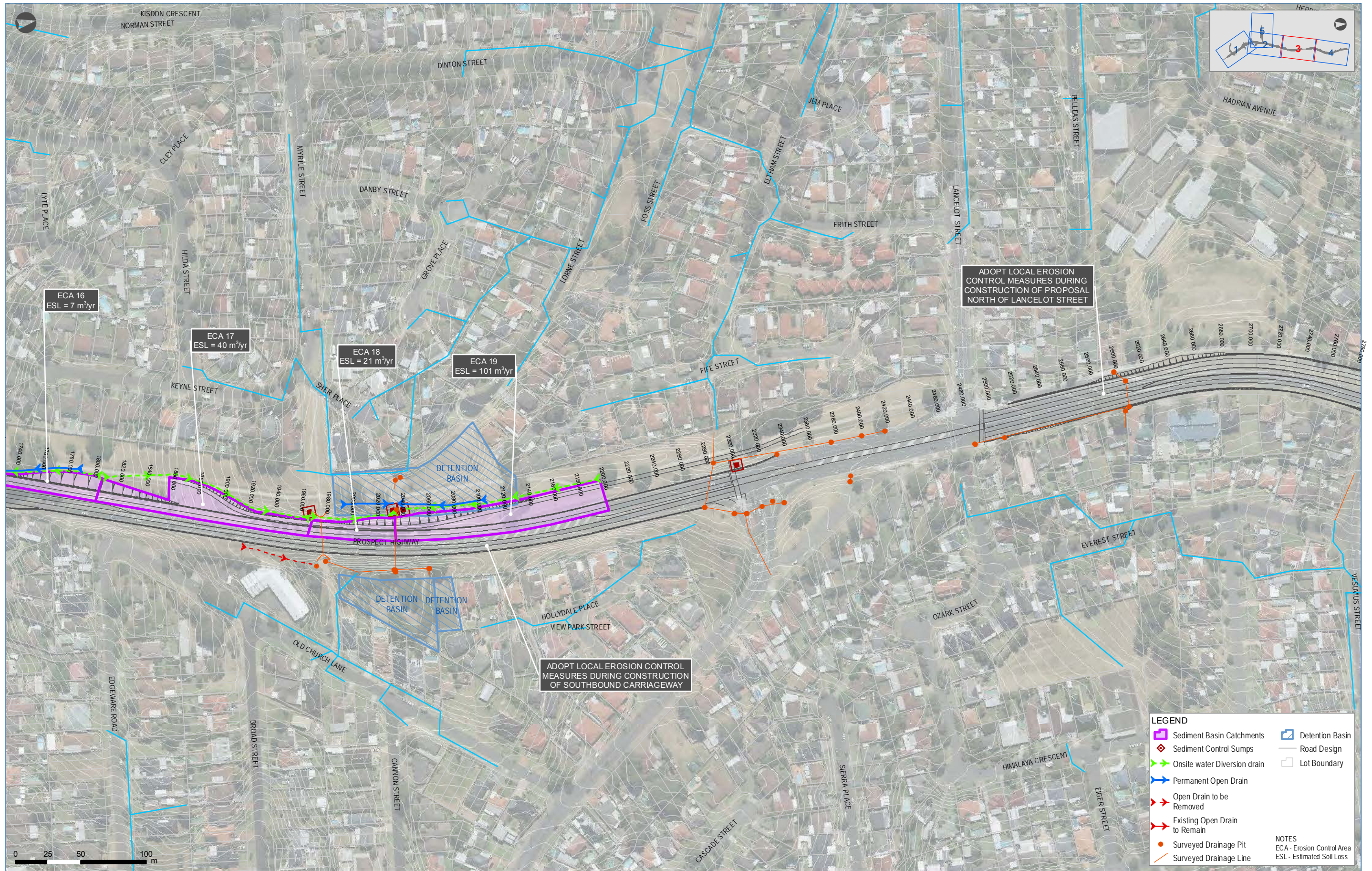


FIGURE 4-3 - EROSION AND SEDIMENT CONTROL (SHEET 3 of 5)

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FIGURE 4-4 - EROSION AND SEDIMENT CONTROL (SHEET 4 of 5)

1:2,750 @ A3

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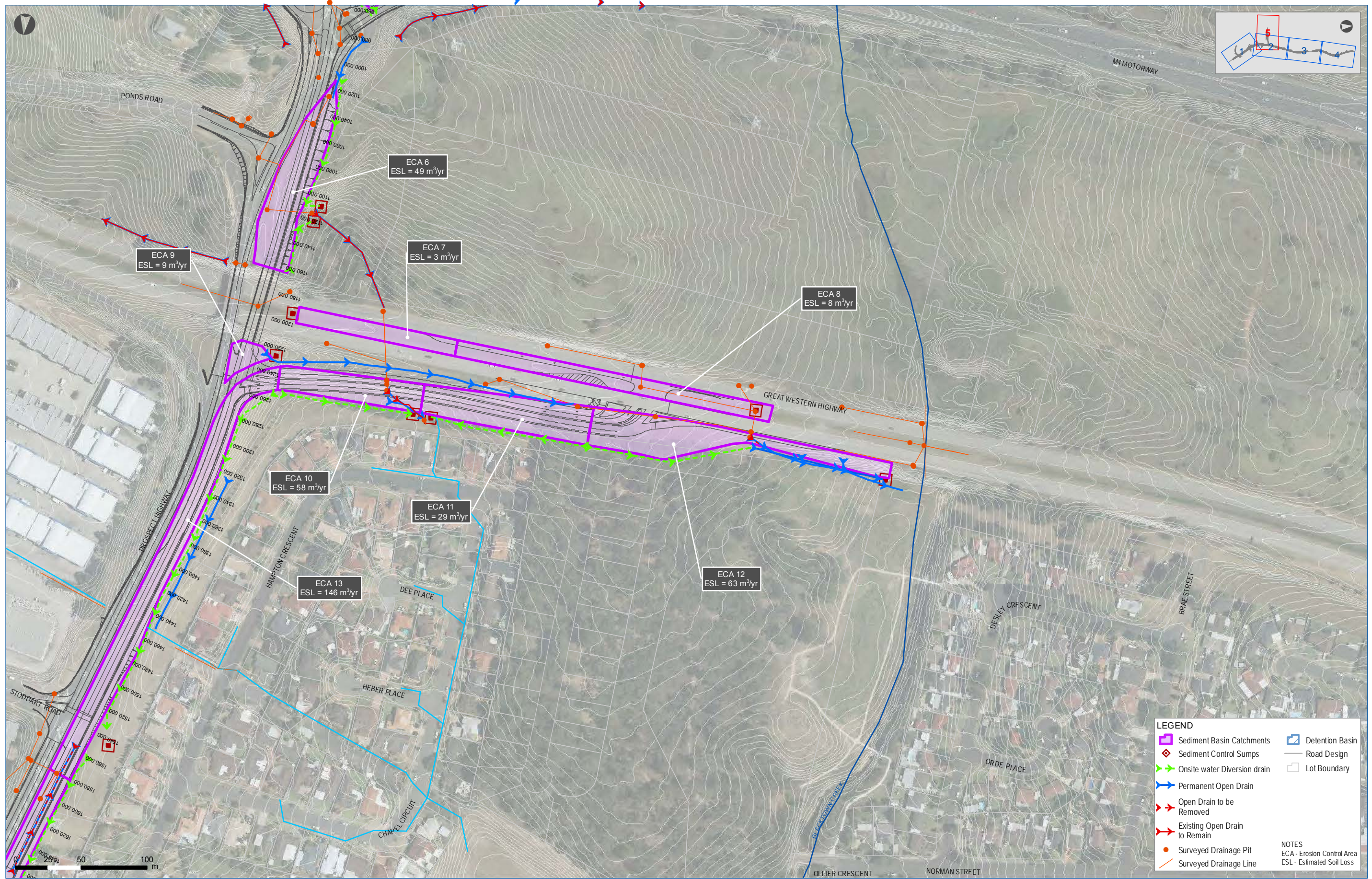


FIGURE 4-5 - EROSION AND SEDIMENT CONTROL (SHEET 5 of 5)

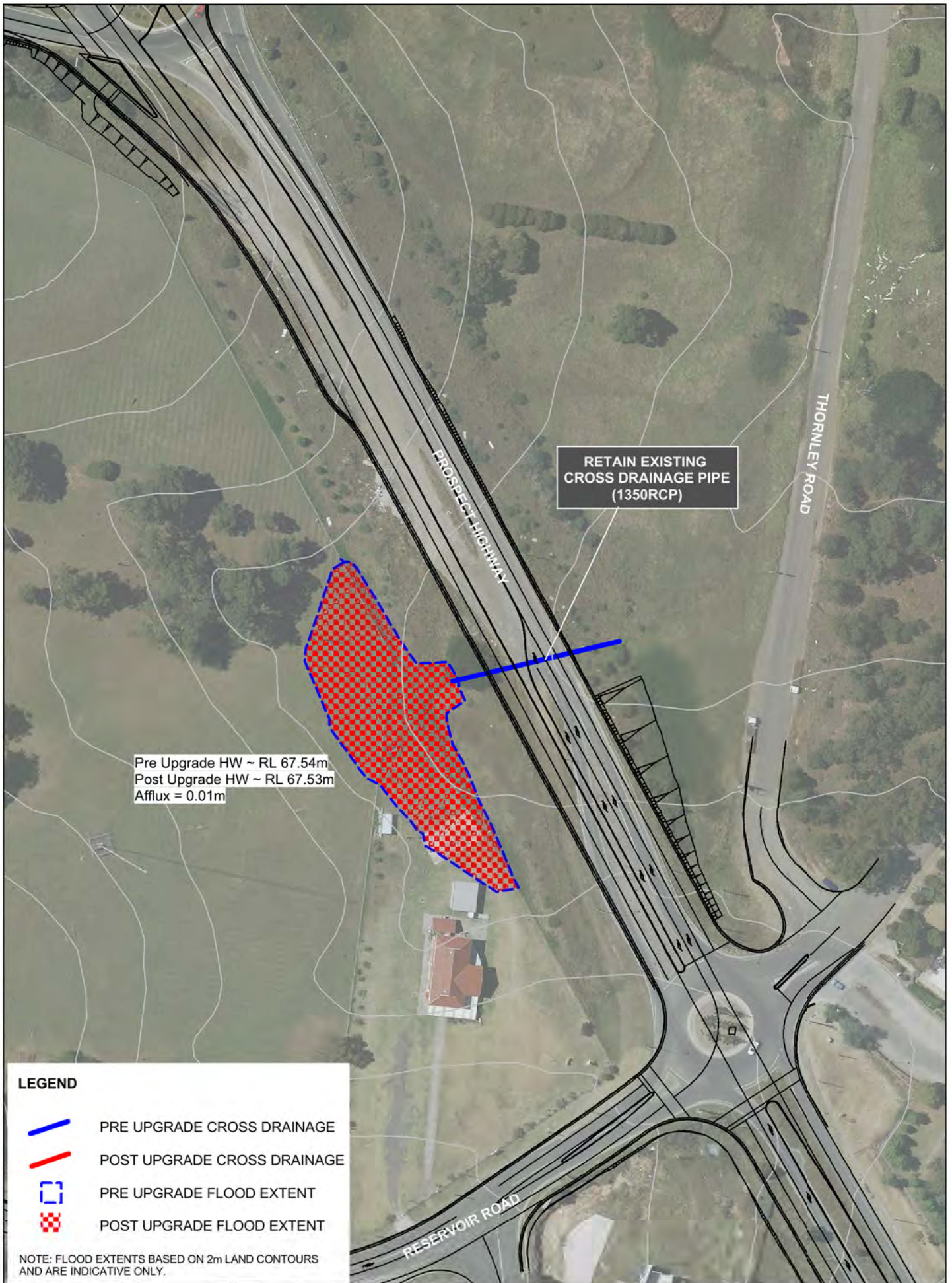
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Level 5, 141 Walker St  
North Sydney NSW 2060











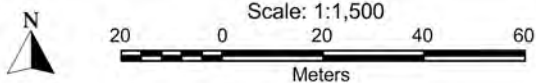
Pre Upgrade HW ~ RL 67.54m  
 Post Upgrade HW ~ RL 67.53m  
 Afflux = 0.01m

RETAIN EXISTING  
 CROSS DRAINAGE PIPE  
 (1350RCP)

**LEGEND**

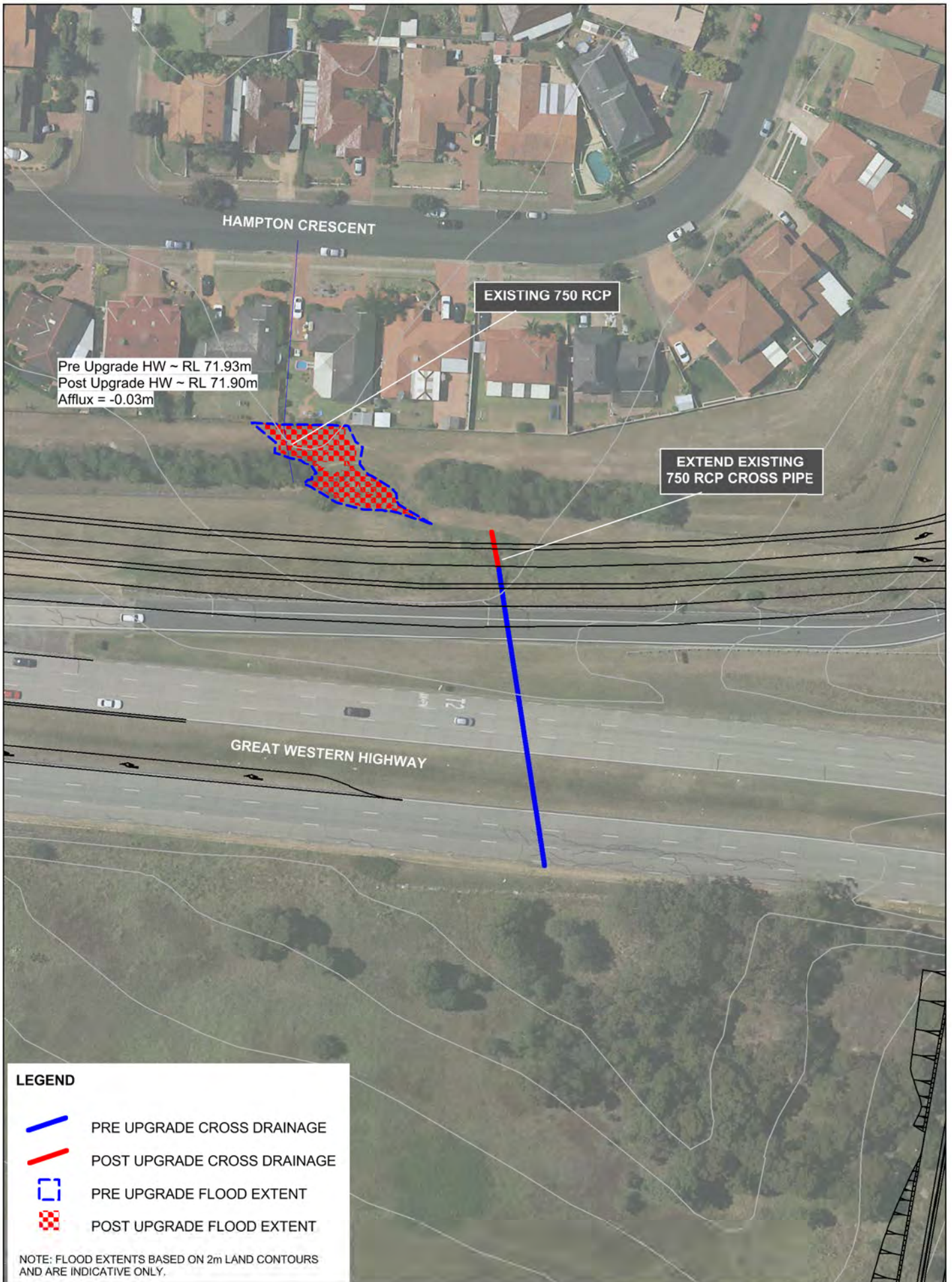
-  PRE UPGRADE CROSS DRAINAGE
-  POST UPGRADE CROSS DRAINAGE
-  PRE UPGRADE FLOOD EXTENT
-  POST UPGRADE FLOOD EXTENT

NOTE: FLOOD EXTENTS BASED ON 2m LAND CONTOURS AND ARE INDICATIVE ONLY.



**PROSPECT HIGHWAY UPGRADE  
 DRAINAGE INVESTIGATION**  
 Figure 5-1 - Peak 100 Year ARI Head Water Level  
 Culvert Crossing MC10 - 460





Pre Upgrade HW ~ RL 71.93m  
 Post Upgrade HW ~ RL 71.90m  
 Afflux = -0.03m





EXISTING 750 RCP

EXTEND EXISTING  
 750 RCP CROSS PIPE

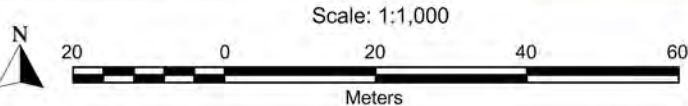
GREAT WESTERN HIGHWAY

HAMPTON CRESCENT

**LEGEND**

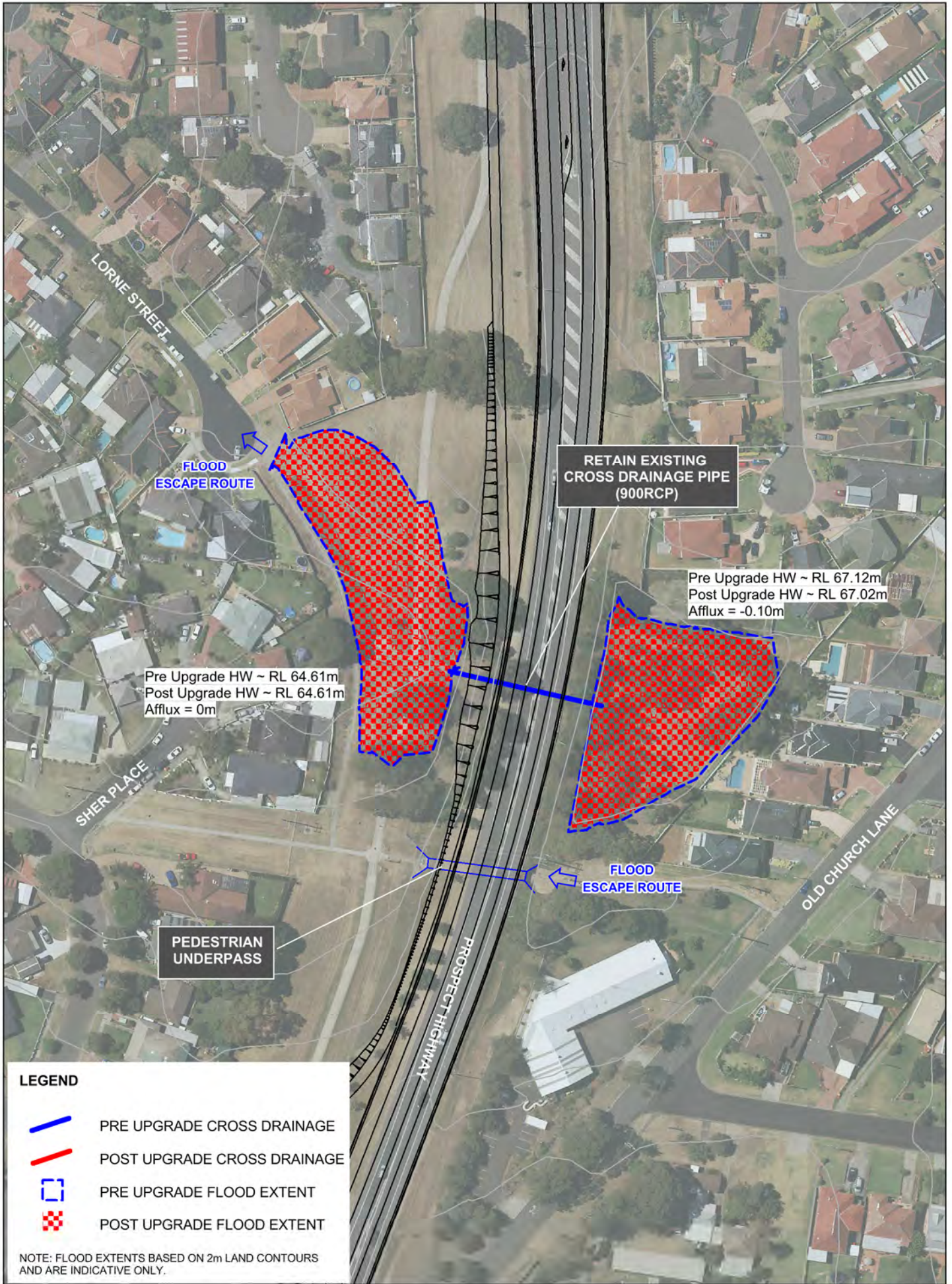
-  PRE UPGRADE CROSS DRAINAGE
-  POST UPGRADE CROSS DRAINAGE
-  PRE UPGRADE FLOOD EXTENT
-  POST UPGRADE FLOOD EXTENT

NOTE: FLOOD EXTENTS BASED ON 2m LAND CONTOURS AND ARE INDICATIVE ONLY.







**PROSPECT HIGHWAY UPGRADE  
 DRAINAGE INVESTIGATION**  
 Figure 5-2 - Peak 100 Year ARI Head Water Level  
 Culvert Crossing MX01 - 110

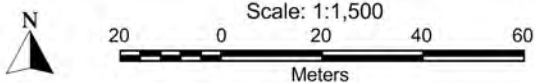




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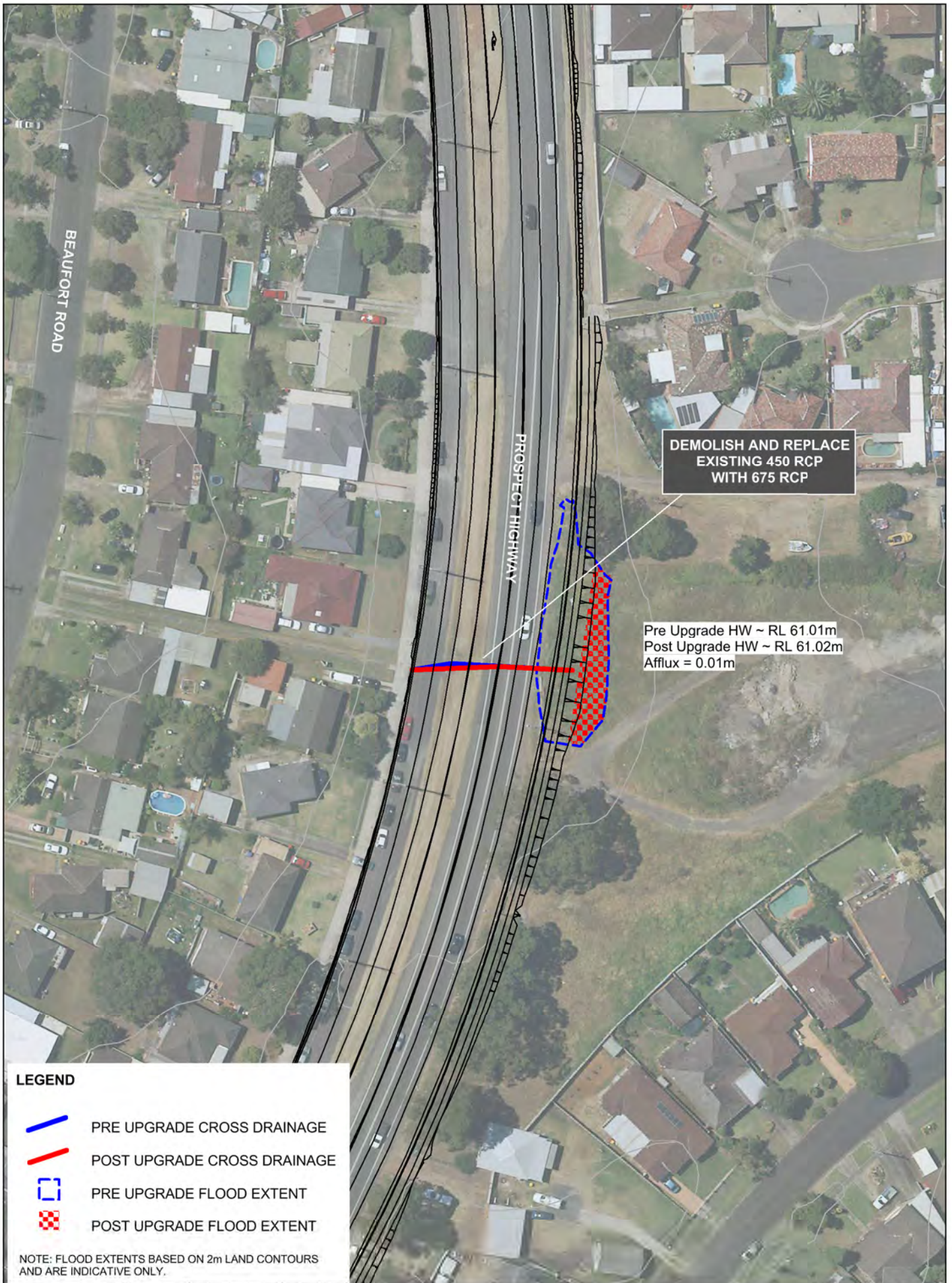
-  PRE UPGRADE CROSS DRAINAGE
-  POST UPGRADE CROSS DRAINAGE
-  PRE UPGRADE FLOOD EXTENT
-  POST UPGRADE FLOOD EXTENT

NOTE: FLOOD EXTENTS BASED ON 2m LAND CONTOURS AND ARE INDICATIVE ONLY.







**PROSPECT HIGHWAY UPGRADE  
DRAINAGE INVESTIGATION**  
Figure 5-3 - Peak 100 Year ARI Head Water Level  
Culvert Crossing MC10 - 2034

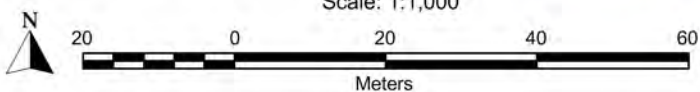




**LEGEND**

-  PRE UPGRADE CROSS DRAINAGE
-  POST UPGRADE CROSS DRAINAGE
-  PRE UPGRADE FLOOD EXTENT
-  POST UPGRADE FLOOD EXTENT

NOTE: FLOOD EXTENTS BASED ON 2m LAND CONTOURS AND ARE INDICATIVE ONLY.



**PROSPECT HIGHWAY UPGRADE  
DRAINAGE INVESTIGATION**  
Figure 5-4 - Peak 100 Year ARI Head Water Level  
Culvert Crossing MC10 - 3100

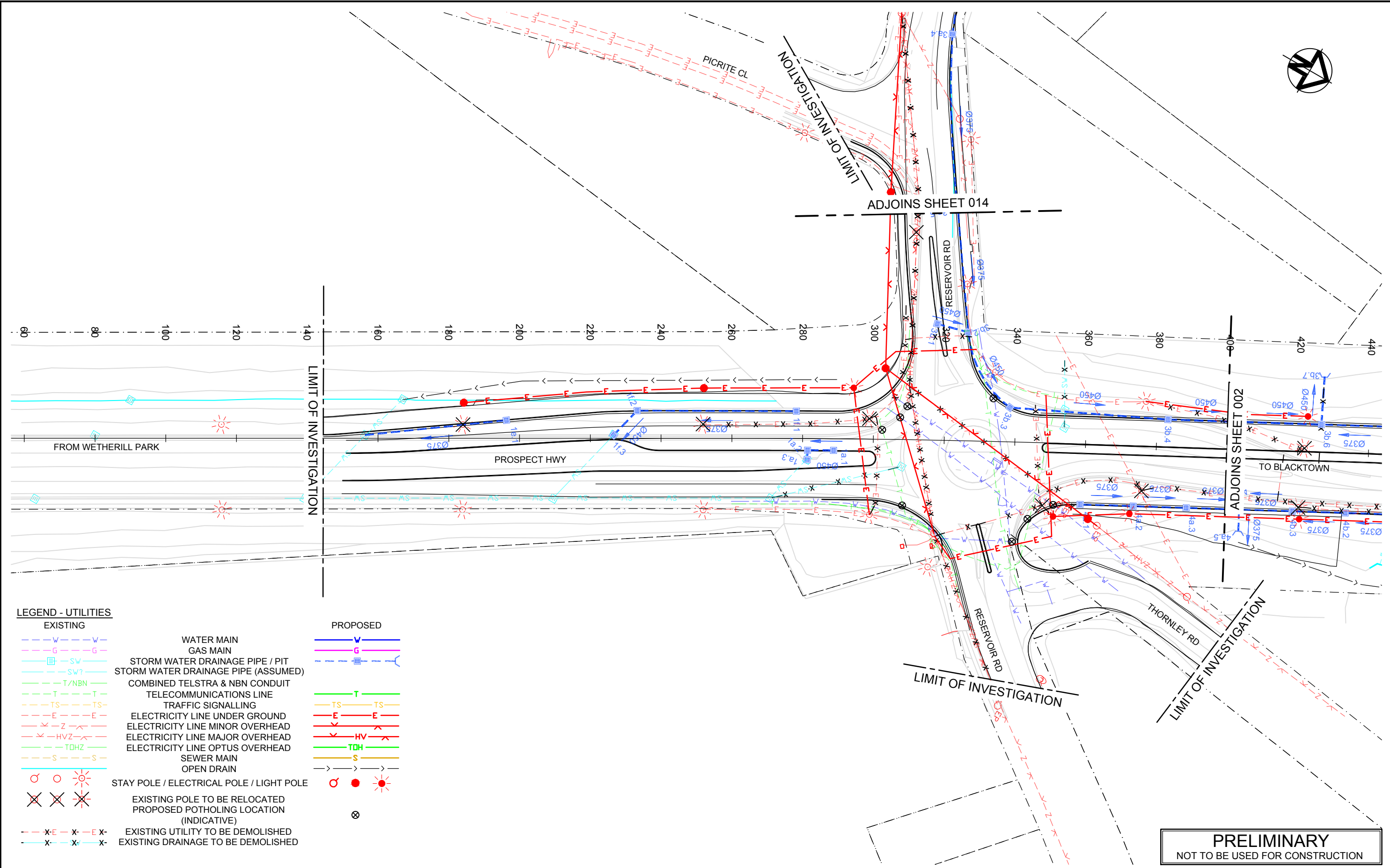


APPENDIX B

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CONCEPT DRAINAGE LAYOUT AND  
LONGITUDINAL SECTIONS

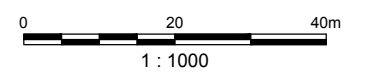




**LEGEND - UTILITIES**

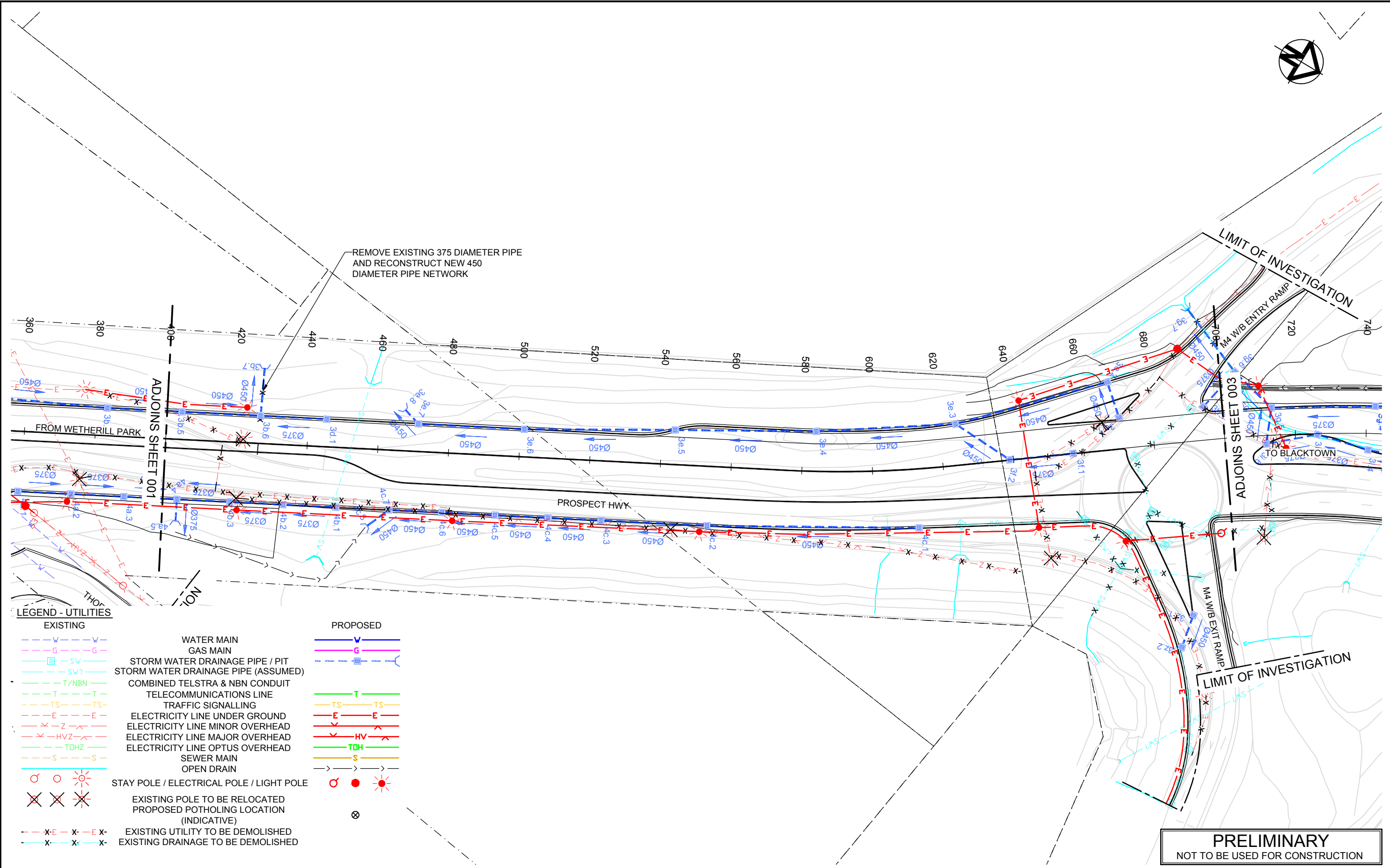
EXISTING		PROPOSED	
	WATER MAIN		WATER MAIN
	GAS MAIN		GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT		STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)		STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT		COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE		TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING		TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND		ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD		ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD		ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD		ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN		SEWER MAIN
	OPEN DRAIN		OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE		STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED		PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED		EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED		EXISTING DRAINAGE TO BE DEMOLISHED

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



CONCEPT DRAINAGE DESIGN

SHEET 1 OF 15



REMOVE EXISTING 375 DIAMETER PIPE AND RECONSTRUCT NEW 450 DIAMETER PIPE NETWORK

LIMIT OF INVESTIGATION

LIMIT OF INVESTIGATION

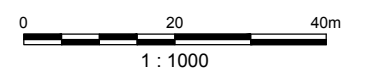
ADJOINS SHEET 001

ADJOINS SHEET 003

LEGEND - UTILITIES

- |   |   |
|---|---|
| <b>EXISTING</b>                               | <b>PROPOSED</b>                               |
| W - WATER MAIN                                | W - WATER MAIN                                |
| G - GAS MAIN                                  | G - GAS MAIN                                  |
| SW - STORM WATER DRAINAGE PIPE / PIT          | SW - STORM WATER DRAINAGE PIPE / PIT          |
| SW? - STORM WATER DRAINAGE PIPE (ASSUMED)     | SW? - STORM WATER DRAINAGE PIPE (ASSUMED)     |
| T/NBN - COMBINED TELSTRA & NBN CONDUIT        | T - TELECOMMUNICATIONS LINE                   |
| T - TELECOMMUNICATIONS LINE                   | TS - TRAFFIC SIGNALLING                       |
| TS - TRAFFIC SIGNALLING                       | E - ELECTRICITY LINE UNDER GROUND             |
| E - ELECTRICITY LINE UNDER GROUND             | E - ELECTRICITY LINE MINOR OVERHEAD           |
| Z - ELECTRICITY LINE MINOR OVERHEAD           | HV - ELECTRICITY LINE MAJOR OVERHEAD          |
| HV - ELECTRICITY LINE MAJOR OVERHEAD          | TOH - ELECTRICITY LINE OPTUS OVERHEAD         |
| TOH - ELECTRICITY LINE OPTUS OVERHEAD         | S - SEWER MAIN                                |
| S - SEWER MAIN                                | OD - OPEN DRAIN                               |
| OP - OPEN DRAIN                               | SP - STAY POLE / ELECTRICAL POLE / LIGHT POLE |
| SP - STAY POLE / ELECTRICAL POLE / LIGHT POLE | RP - EXISTING POLE TO BE RELOCATED            |
| RP - EXISTING POLE TO BE RELOCATED            | PL - PROPOSED POTHOLING LOCATION (INDICATIVE) |
| PL - PROPOSED POTHOLING LOCATION (INDICATIVE) | EX - EXISTING UTILITY TO BE DEMOLISHED        |
| EX - EXISTING UTILITY TO BE DEMOLISHED        | ED - EXISTING DRAINAGE TO BE DEMOLISHED       |
| ED - EXISTING DRAINAGE TO BE DEMOLISHED       |   |

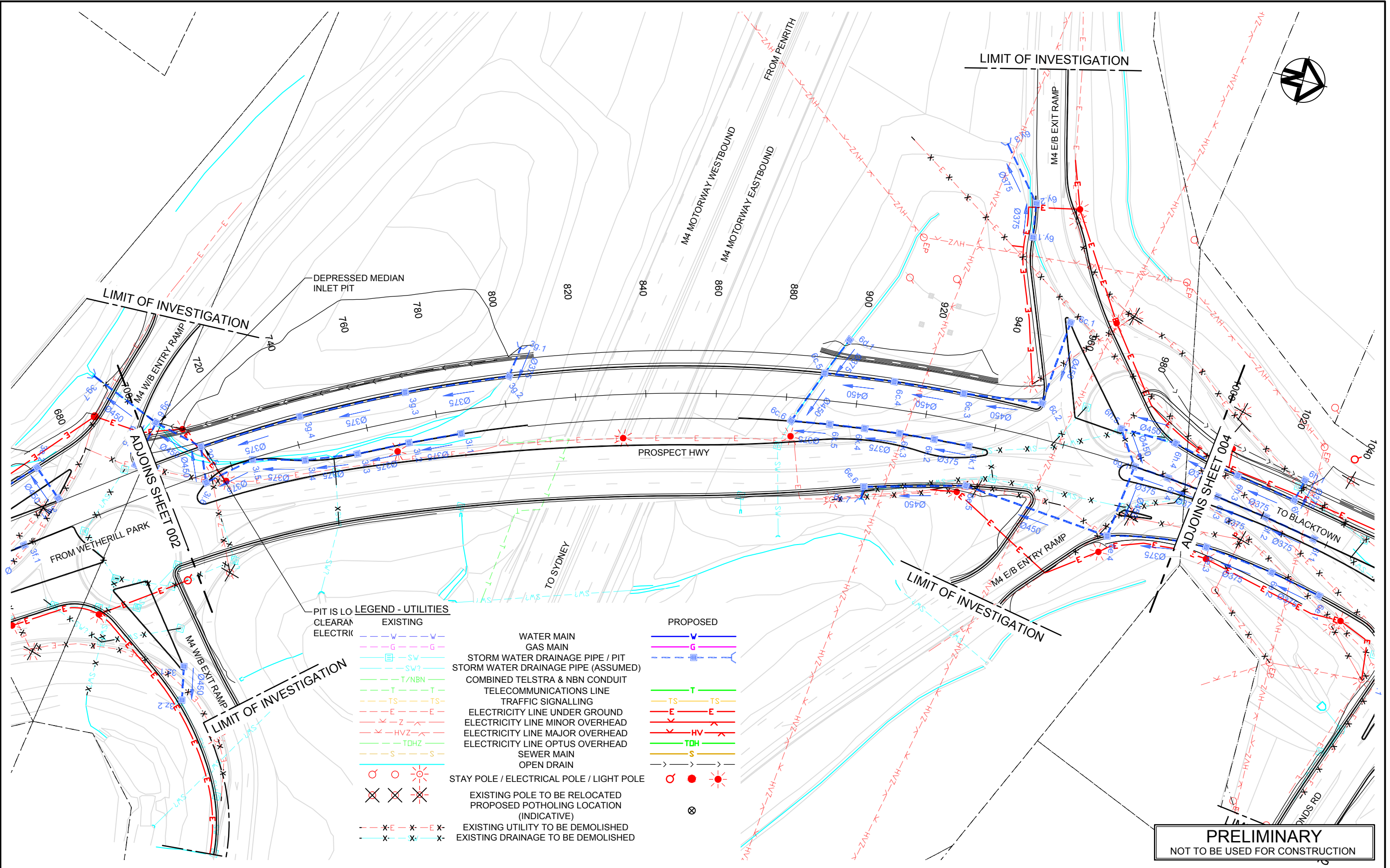
PRELIMINARY  
NOT TO BE USED FOR CONSTRUCTION



CONCEPT DRAINAGE DESIGN

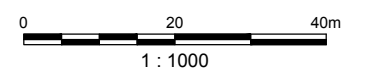
SHEET 2 OF 15





LEGEND - UTILITIES		PROPOSED	
— W —	WATER MAIN	— W —	WATER MAIN
— G —	GAS MAIN	— G —	GAS MAIN
— SW —	STORM WATER DRAINAGE PIPE / PIT	— SW —	STORM WATER DRAINAGE PIPE / PIT
— SW? —	STORM WATER DRAINAGE PIPE (ASSUMED)	— SW? —	STORM WATER DRAINAGE PIPE (ASSUMED)
— T/NBN —	COMBINED TELSTRA & NBN CONDUIT	— T —	TELECOMMUNICATIONS LINE
— T —	TELECOMMUNICATIONS LINE	— TS —	TRAFFIC SIGNALLING
— TS —	TRAFFIC SIGNALLING	— E —	ELECTRICITY LINE UNDER GROUND
— E —	ELECTRICITY LINE UNDER GROUND	— E —	ELECTRICITY LINE MINOR OVERHEAD
— Z —	ELECTRICITY LINE MINOR OVERHEAD	— HV —	ELECTRICITY LINE MAJOR OVERHEAD
— HVZ —	ELECTRICITY LINE MAJOR OVERHEAD	— THZ —	ELECTRICITY LINE OPTUS OVERHEAD
— THZ —	ELECTRICITY LINE OPTUS OVERHEAD	— S —	SEWER MAIN
— S —	SEWER MAIN	— S —	SEWER MAIN
— O —	OPEN DRAIN	— O —	OPEN DRAIN
⊙	STAY POLE / ELECTRICAL POLE / LIGHT POLE	⊙	STAY POLE / ELECTRICAL POLE / LIGHT POLE
⊗	EXISTING POLE TO BE RELOCATED	⊗	EXISTING POLE TO BE RELOCATED
⊗	PROPOSED POTHOLING LOCATION (INDICATIVE)	⊗	PROPOSED POTHOLING LOCATION (INDICATIVE)
— X —	EXISTING UTILITY TO BE DEMOLISHED	— X —	EXISTING UTILITY TO BE DEMOLISHED
— X —	EXISTING DRAINAGE TO BE DEMOLISHED	— X —	EXISTING DRAINAGE TO BE DEMOLISHED

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

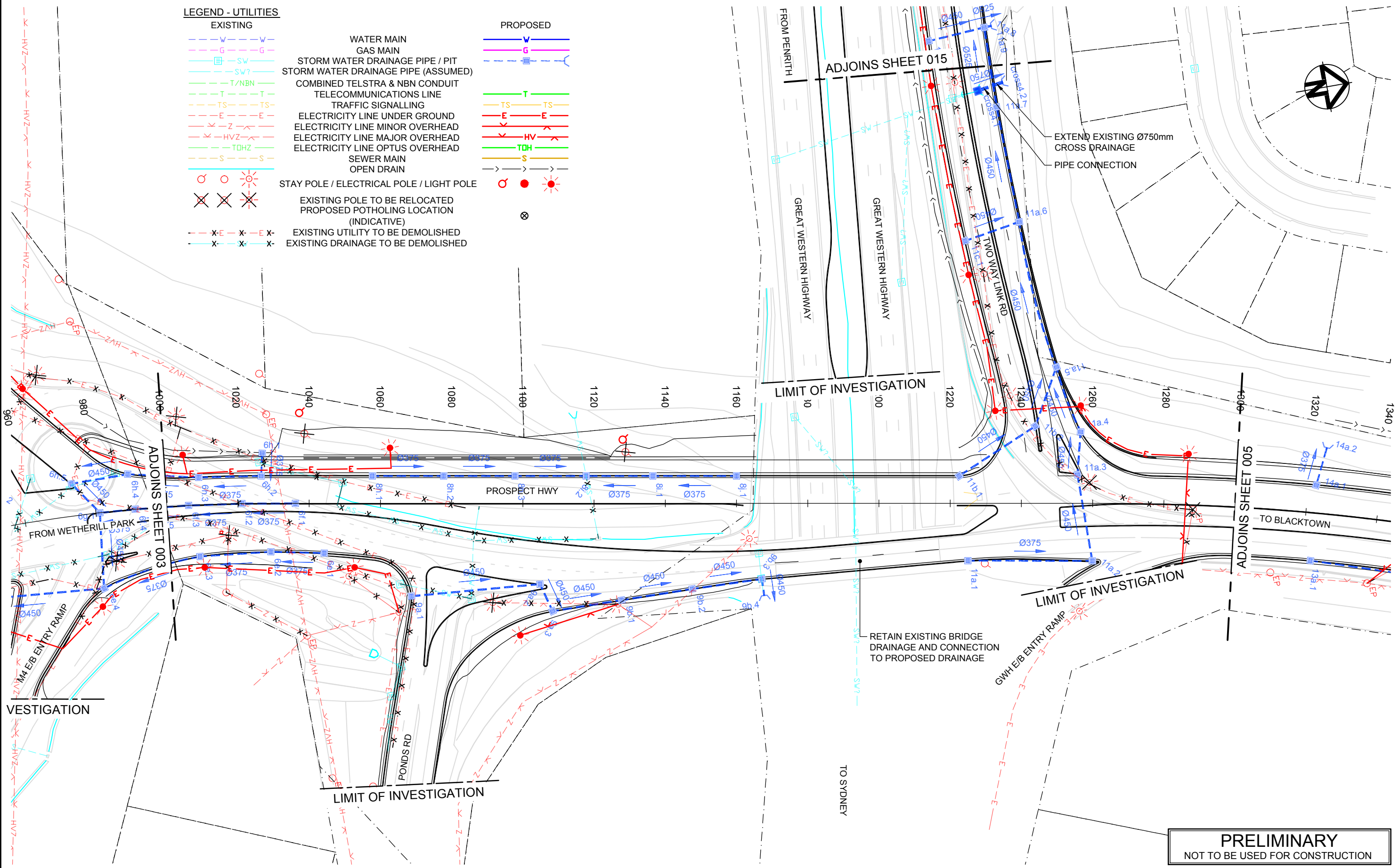


CONCEPT DRAINAGE DESIGN

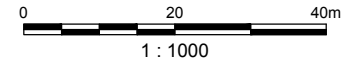
SHEET 3 OF 15

**LEGEND - UTILITIES**

EXISTING		PROPOSED	
	WATER MAIN		WATER MAIN
	GAS MAIN		GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT		STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)		STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT		COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE		TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING		TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND		ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD		ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD		ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD		ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN		SEWER MAIN
	OPEN DRAIN		OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE		STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED		EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)		PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED		EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED		EXISTING DRAINAGE TO BE DEMOLISHED



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

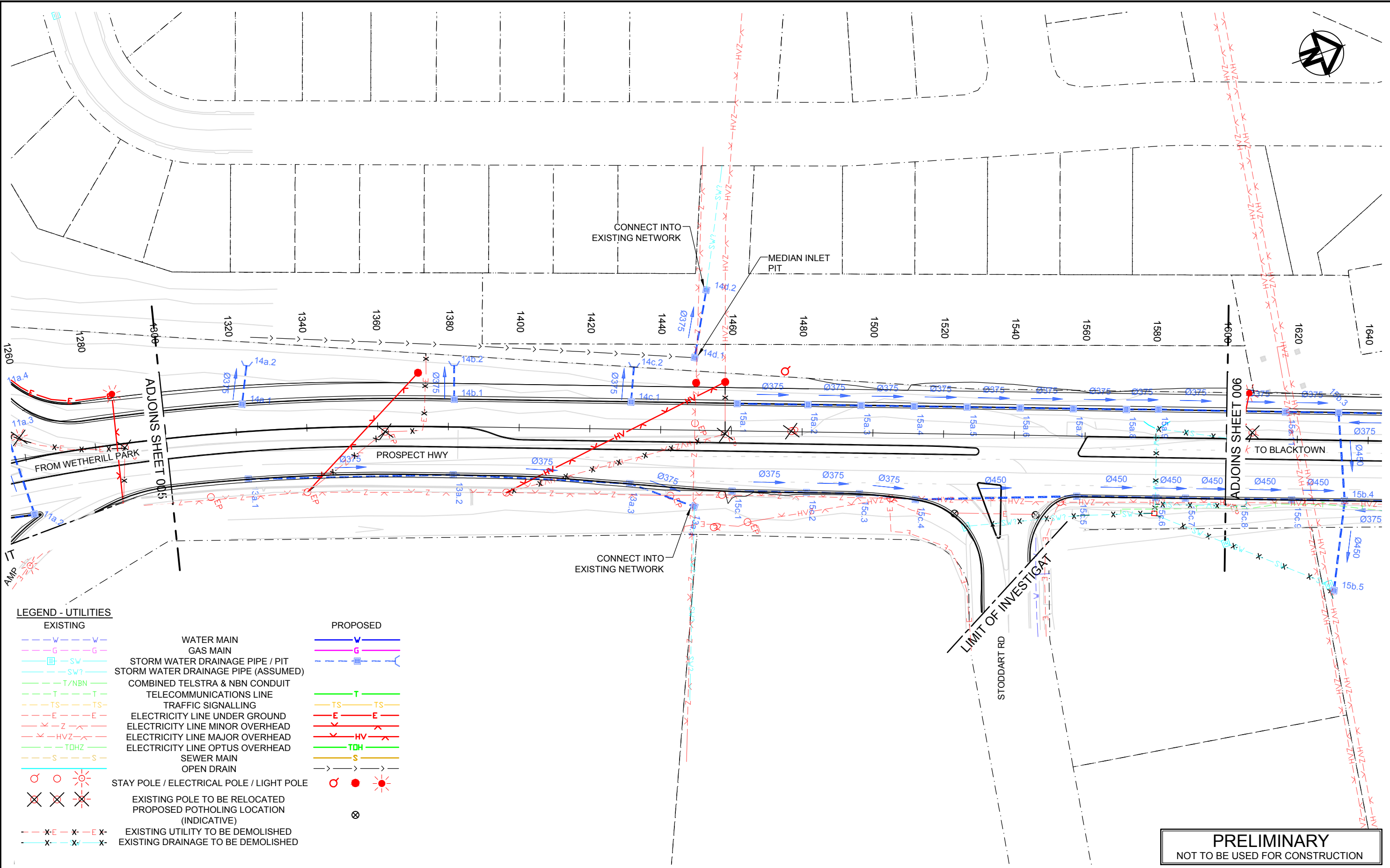


CONCEPT DRAINAGE DESIGN

SCALE AT A3

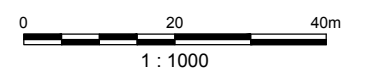
SHEET 4 OF 15



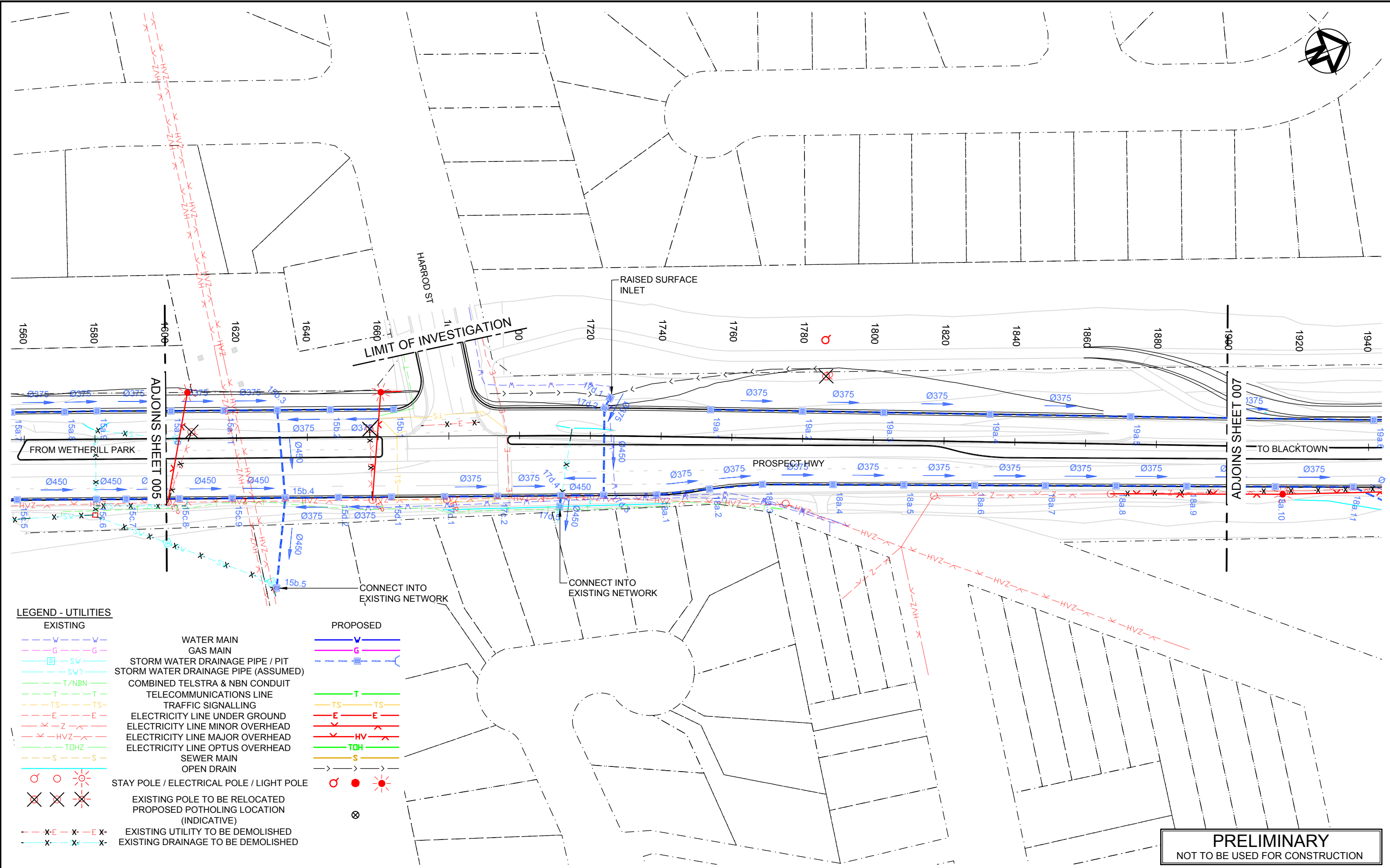


LEGEND - UTILITIES		EXISTING		PROPOSED	
	WATER MAIN				
	GAS MAIN				
	STORM WATER DRAINAGE PIPE / PIT				
	STORM WATER DRAINAGE PIPE (ASSUMED)				
	COMBINED TELSTRA & NBN CONDUIT				
	TELECOMMUNICATIONS LINE				
	TRAFFIC SIGNALLING				
	ELECTRICITY LINE UNDER GROUND				
	ELECTRICITY LINE MINOR OVERHEAD				
	ELECTRICITY LINE MAJOR OVERHEAD				
	ELECTRICITY LINE OPTUS OVERHEAD				
	SEWER MAIN				
	OPEN DRAIN				
	STAY POLE / ELECTRICAL POLE / LIGHT POLE				
	EXISTING POLE TO BE RELOCATED				
	PROPOSED POTHOLING LOCATION (INDICATIVE)				
	EXISTING UTILITY TO BE DEMOLISHED				
	EXISTING DRAINAGE TO BE DEMOLISHED				

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



CONCEPT DRAINAGE DESIGN



**LEGEND - UTILITIES**  
EXISTING

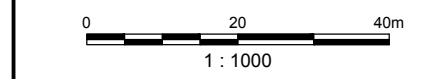
- W-W- WATER MAIN
- G-G- GAS MAIN
- SW- STORM WATER DRAINAGE PIPE / PIT
- SW?- STORM WATER DRAINAGE PIPE (ASSUMED)
- T/NBN- COMBINED TELSTRA & NBN CONDUIT
- T- TELECOMMUNICATIONS LINE
- TS-TS- TRAFFIC SIGNALLING
- E-E- ELECTRICITY LINE UNDER GROUND
- Z-Z- ELECTRICITY LINE MINOR OVERHEAD
- HVZ-HVZ- ELECTRICITY LINE MAJOR OVERHEAD
- TOHZ- ELECTRICITY LINE OPTUS OVERHEAD
- S-S- SEWER MAIN
- >- OPEN DRAIN
- ☉ STAY POLE / ELECTRICAL POLE / LIGHT POLE
- ⊗ EXISTING POLE TO BE RELOCATED
- ⊙ PROPOSED POTHOLING LOCATION (INDICATIVE)
- x-E-x- EXISTING UTILITY TO BE DEMOLISHED
- x-S-x- EXISTING DRAINAGE TO BE DEMOLISHED

**PROPOSED**

- V- WATER MAIN
- G- GAS MAIN
- T- TELECOMMUNICATIONS LINE
- TS-TS- TRAFFIC SIGNALLING
- E-E- ELECTRICITY LINE UNDER GROUND
- HV-HV- ELECTRICITY LINE MAJOR OVERHEAD
- TOH- ELECTRICITY LINE OPTUS OVERHEAD
- S- SEWER MAIN
- ☉ STAY POLE / ELECTRICAL POLE / LIGHT POLE
- ⊗ PROPOSED POTHOLING LOCATION (INDICATIVE)

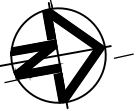
**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

CONCEPT DRAINAGE DESIGN



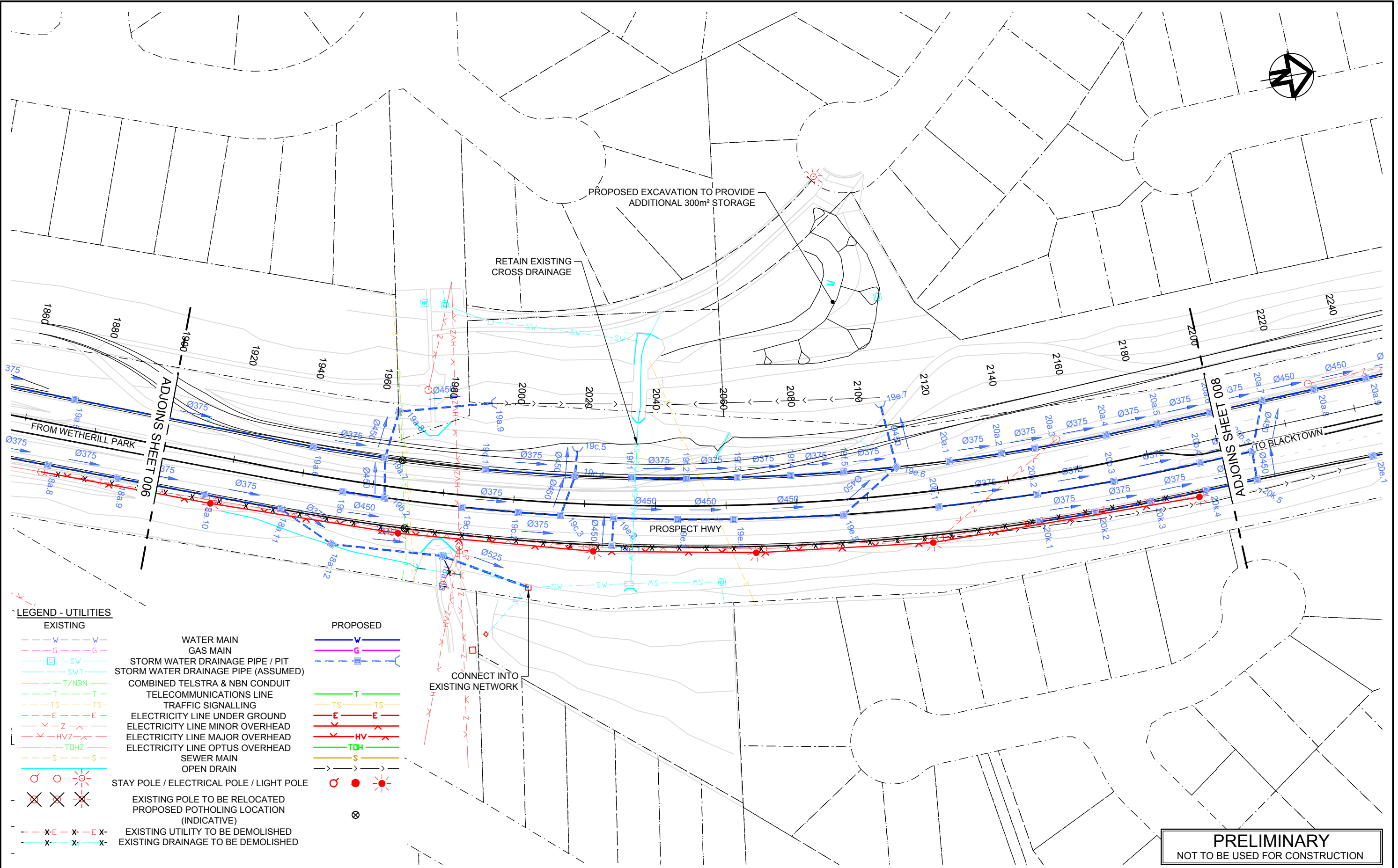
SHEET 6 OF 15





PROPOSED EXCAVATION TO PROVIDE  
ADDITIONAL 300m<sup>2</sup> STORAGE

RETAIN EXISTING  
CROSS DRAINAGE



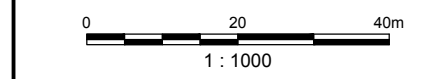
**LEGEND - UTILITIES**

- |                 |  |                 |  |
|-----------------|--|-----------------|--|
| <b>EXISTING</b> |  | <b>PROPOSED</b> |  |
|                 | WATER MAIN                               |                 | WATER MAIN                               |
|                 | GAS MAIN                                 |                 | GAS MAIN                                 |
|                 | STORM WATER DRAINAGE PIPE / PIT          |                 | STORM WATER DRAINAGE PIPE / PIT          |
|                 | STORM WATER DRAINAGE PIPE (ASSUMED)      |                 | STORM WATER DRAINAGE PIPE (ASSUMED)      |
|                 | COMBINED TELSTRA & NBN CONDUIT           |                 | COMBINED TELSTRA & NBN CONDUIT           |
|                 | TELECOMMUNICATIONS LINE                  |                 | TELECOMMUNICATIONS LINE                  |
|                 | TRAFFIC SIGNALLING                       |                 | TRAFFIC SIGNALLING                       |
|                 | ELECTRICITY LINE UNDER GROUND            |                 | ELECTRICITY LINE UNDER GROUND            |
|                 | ELECTRICITY LINE MINOR OVERHEAD          |                 | ELECTRICITY LINE MINOR OVERHEAD          |
|                 | ELECTRICITY LINE MAJOR OVERHEAD          |                 | ELECTRICITY LINE MAJOR OVERHEAD          |
|                 | ELECTRICITY LINE OPTUS OVERHEAD          |                 | ELECTRICITY LINE OPTUS OVERHEAD          |
|                 | SEWER MAIN                               |                 | SEWER MAIN                               |
|                 | OPEN DRAIN                               |                 | OPEN DRAIN                               |
|                 | STAY POLE / ELECTRICAL POLE / LIGHT POLE |                 | STAY POLE / ELECTRICAL POLE / LIGHT POLE |
|                 | EXISTING POLE TO BE RELOCATED            |                 | PROPOSED POTHOLING LOCATION (INDICATIVE) |
|                 | PROPOSED POTHOLING LOCATION (INDICATIVE) |                 | EXISTING UTILITY TO BE DEMOLISHED        |
|                 | EXISTING UTILITY TO BE DEMOLISHED        |                 | EXISTING DRAINAGE TO BE DEMOLISHED       |
|                 | EXISTING DRAINAGE TO BE DEMOLISHED       |                 |  |

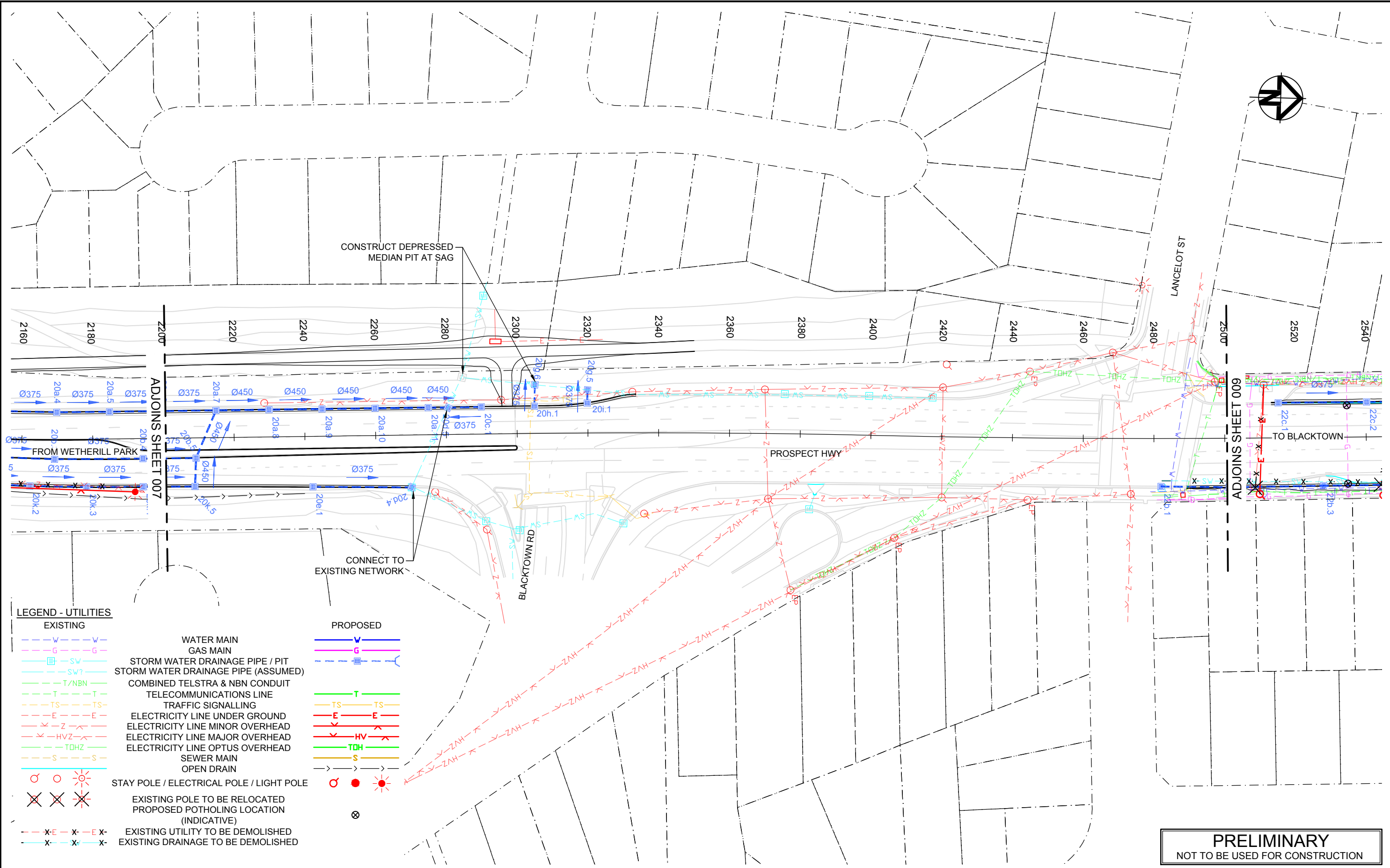
CONNECT INTO  
EXISTING NETWORK

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

CONCEPT DRAINAGE DESIGN

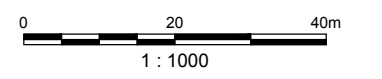


SHEET 7 OF 15



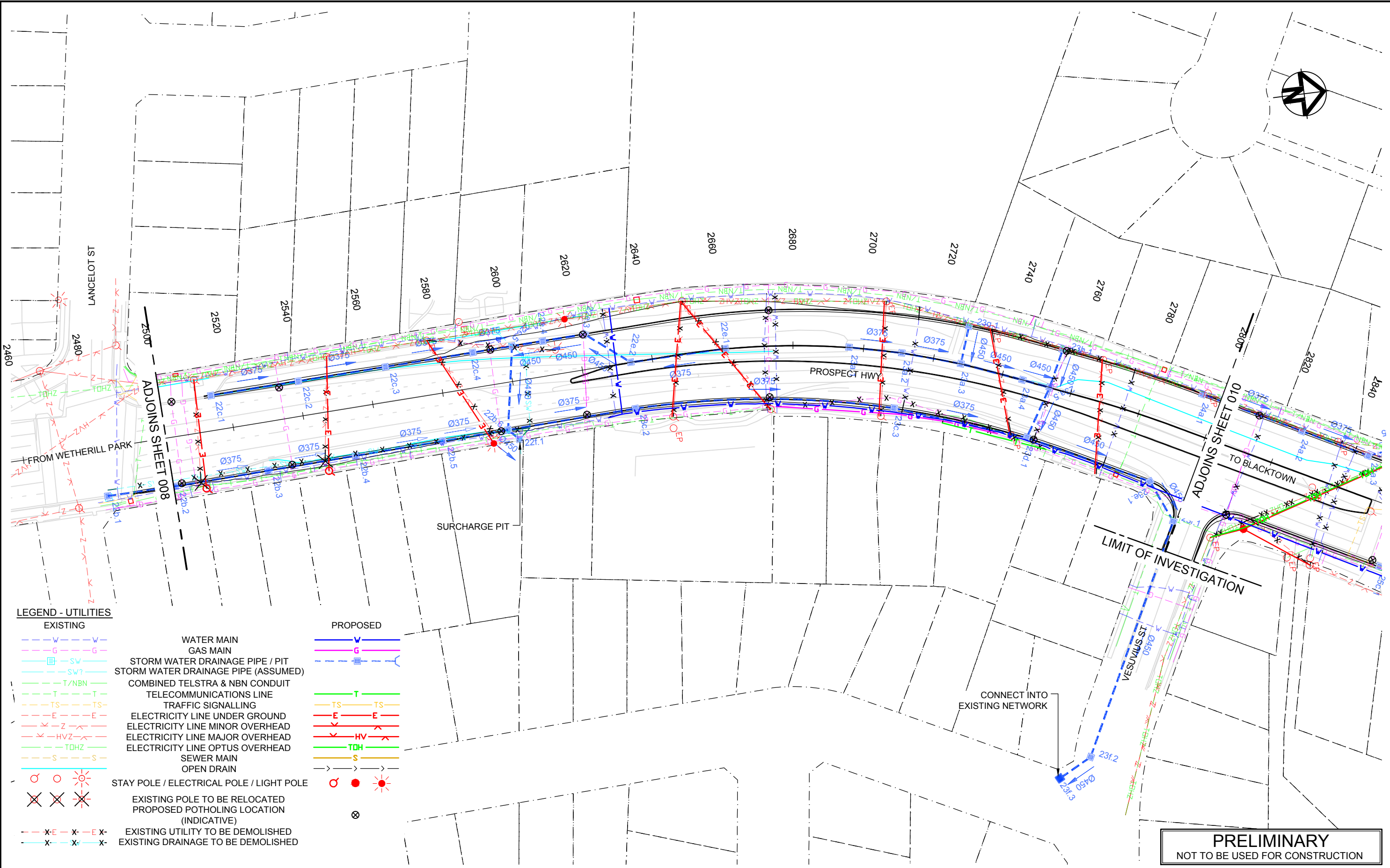
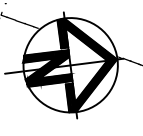
LEGEND - UTILITIES	
<b>EXISTING</b>	
	WATER MAIN
	GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN
	OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED
<b>PROPOSED</b>	
	WATER MAIN
	GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN
	OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



CONCEPT DRAINAGE DESIGN

SHEET 8 OF 15

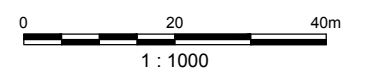


**LEGEND - UTILITIES**

- EXISTING**
- W- W
  - G- G
  - SW- SW
  - SW? SW?
  - T/NBN T/NBN
  - TS- TS
  - E- E
  - Z- Z
  - HVZ HVZ
  - TOHZ TOHZ
  - S- S
- PROPOSED**
- V- V
  - G- G
  - T- T
  - TS- TS
  - E- E
  - HV HV
  - TOHZ TOHZ
  - S- S
- STAY POLE / ELECTRICAL POLE / LIGHT POLE  
 EXISTING POLE TO BE RELOCATED  
 PROPOSED POTHOLING LOCATION (INDICATIVE)  
 EXISTING UTILITY TO BE DEMOLISHED  
 EXISTING DRAINAGE TO BE DEMOLISHED

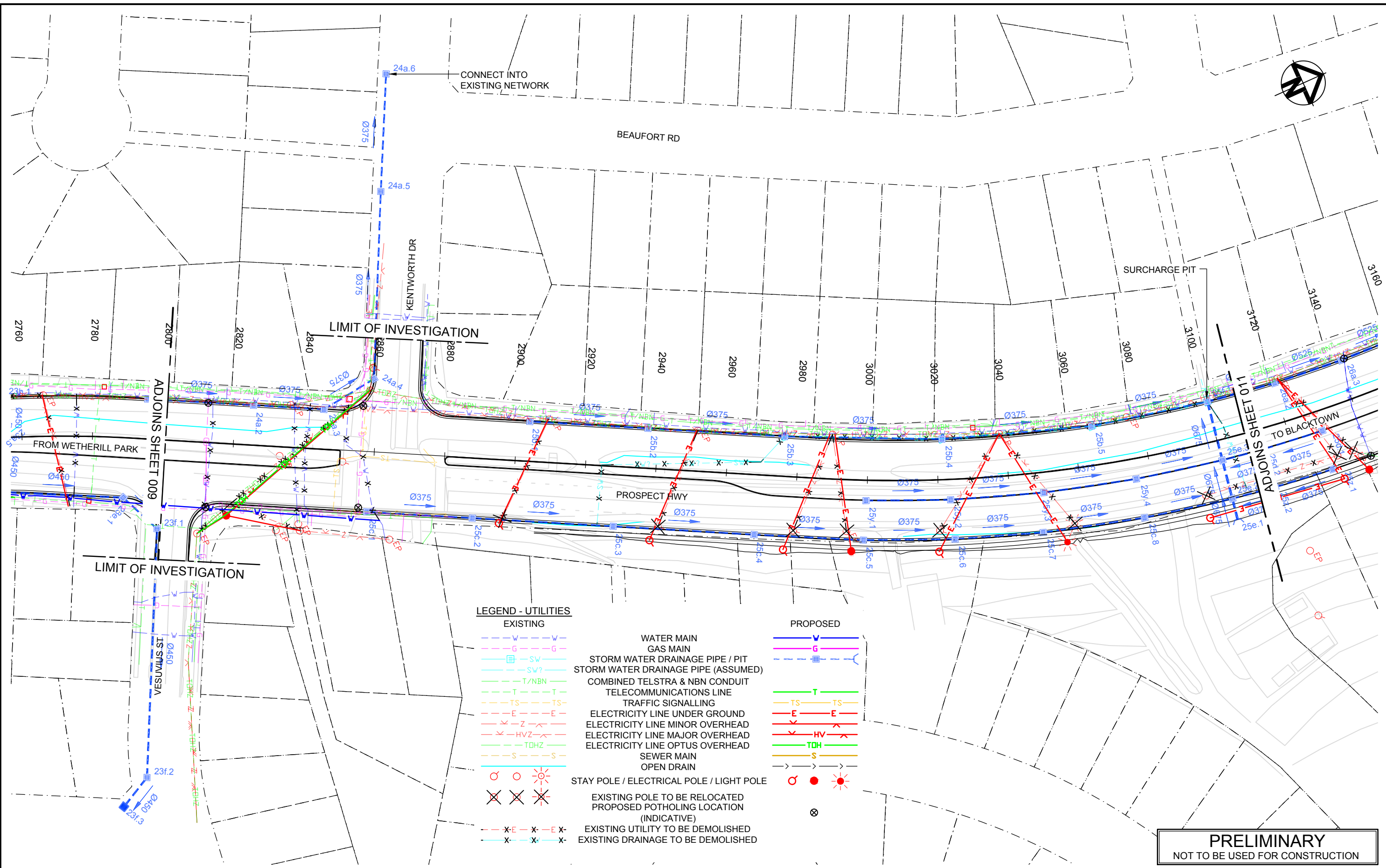
- WATER MAIN
- GAS MAIN
- STORM WATER DRAINAGE PIPE / PIT
- STORM WATER DRAINAGE PIPE (ASSUMED)
- COMBINED TELSTRA & NBN CONDUIT
- TELECOMMUNICATIONS LINE
- TRAFFIC SIGNALLING
- ELECTRICITY LINE UNDER GROUND
- ELECTRICITY LINE MINOR OVERHEAD
- ELECTRICITY LINE MAJOR OVERHEAD
- ELECTRICITY LINE OPTUS OVERHEAD
- SEWER MAIN
- OPEN DRAIN

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



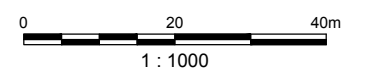
CONCEPT DRAINAGE DESIGN





LEGEND - UTILITIES				
EXISTING	PROPOSED			
W	W	WATER MAIN	W	WATER MAIN
G	G	GAS MAIN	G	GAS MAIN
SW	SW	STORM WATER DRAINAGE PIPE / PIT	SW	STORM WATER DRAINAGE PIPE / PIT
SW?	SW?	STORM WATER DRAINAGE PIPE (ASSUMED)	SW?	STORM WATER DRAINAGE PIPE (ASSUMED)
T/NBN	T/NBN	COMBINED TELSTRA & NBN CONDUIT	T/NBN	COMBINED TELSTRA & NBN CONDUIT
T	T	TELECOMMUNICATIONS LINE	T	TELECOMMUNICATIONS LINE
TS	TS	TRAFFIC SIGNALLING	TS	TRAFFIC SIGNALLING
E	E	ELECTRICITY LINE UNDER GROUND	E	ELECTRICITY LINE UNDER GROUND
Z	Z	ELECTRICITY LINE MINOR OVERHEAD	Z	ELECTRICITY LINE MINOR OVERHEAD
HVZ	HVZ	ELECTRICITY LINE MAJOR OVERHEAD	HVZ	ELECTRICITY LINE MAJOR OVERHEAD
TDHZ	TDHZ	ELECTRICITY LINE OPTUS OVERHEAD	TDHZ	ELECTRICITY LINE OPTus OVERHEAD
S	S	SEWER MAIN	S	SEWER MAIN
—>	—>	OPEN DRAIN	—>	OPEN DRAIN
○	○	STAY POLE / ELECTRICAL POLE / LIGHT POLE	○	STAY POLE / ELECTRICAL POLE / LIGHT POLE
⊗	⊗	EXISTING POLE TO BE RELOCATED	⊗	EXISTING POLE TO BE RELOCATED
⊗	⊗	PROPOSED POTHOLING LOCATION (INDICATIVE)	⊗	PROPOSED POTHOLING LOCATION (INDICATIVE)
-x-	-x-	EXISTING UTILITY TO BE DEMOLISHED	-x-	EXISTING UTILITY TO BE DEMOLISHED
-x-	-x-	EXISTING DRAINAGE TO BE DEMOLISHED	-x-	EXISTING DRAINAGE TO BE DEMOLISHED

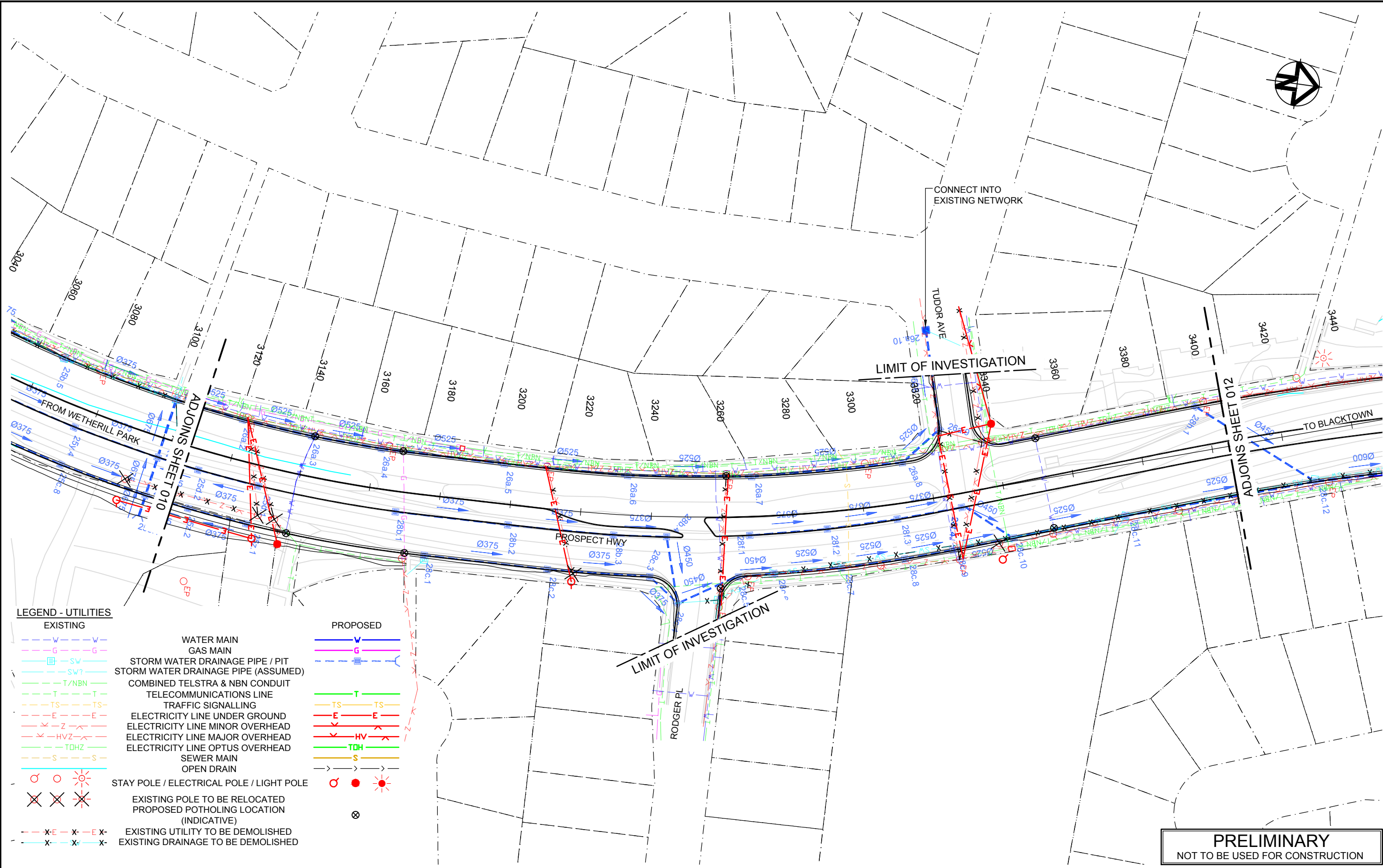
**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



CONCEPT DRAINAGE DESIGN

SHEET 10 OF 15

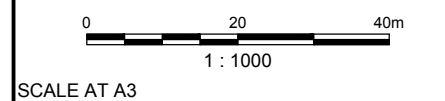




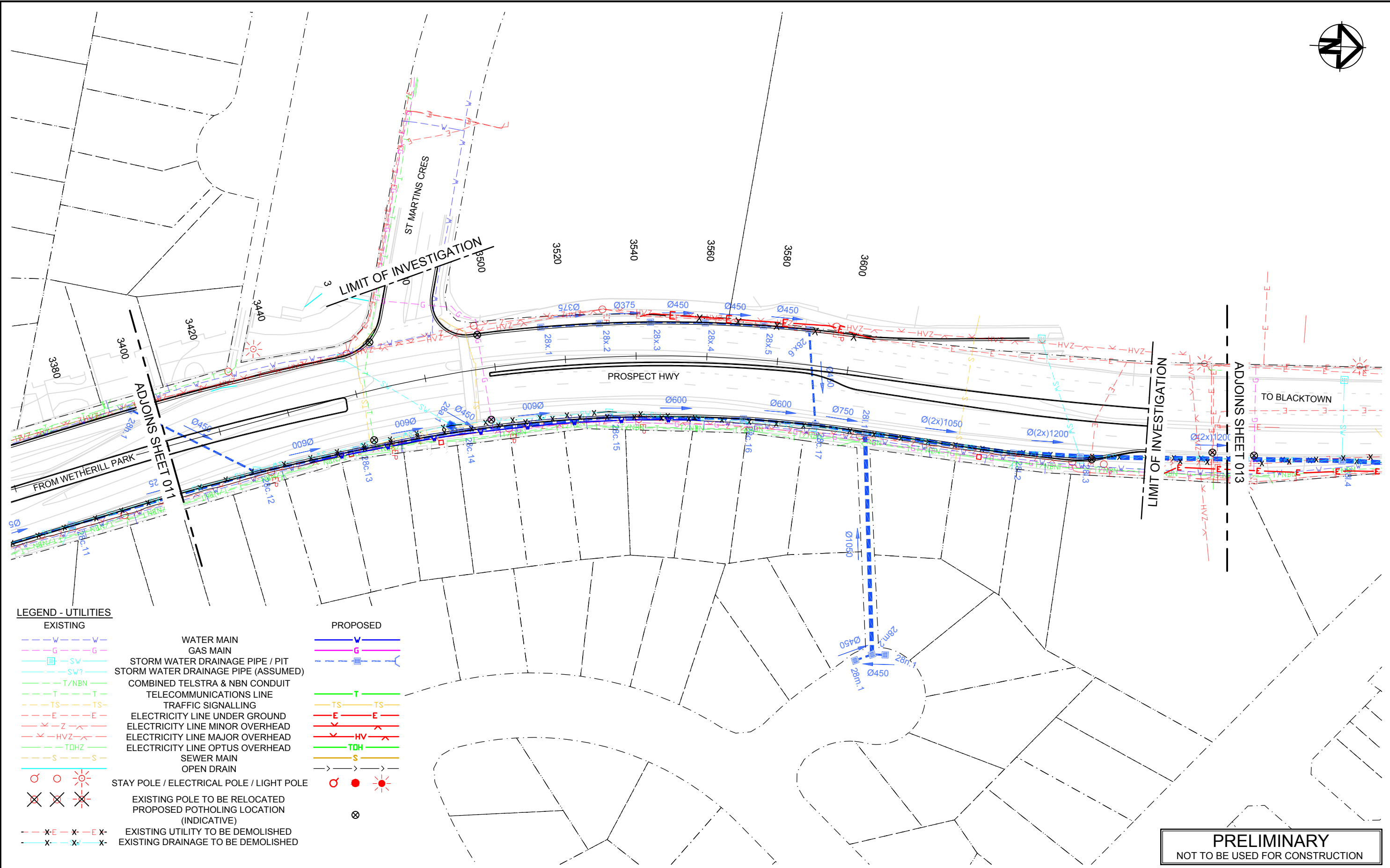
LEGEND - UTILITIES	
<b>EXISTING</b>	
	WATER MAIN
	GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN
	OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED
<b>PROPOSED</b>	
	WATER MAIN
	GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN
	OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

CONCEPT DRAINAGE DESIGN



SHEET 11 OF 15



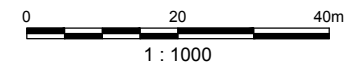
**LEGEND - UTILITIES**  
EXISTING

- WATER MAIN
- GAS MAIN
- STORM WATER DRAINAGE PIPE / PIT
- STORM WATER DRAINAGE PIPE (ASSUMED)
- COMBINED TELSTRA & NBN CONDUIT
- TELECOMMUNICATIONS LINE
- TRAFFIC SIGNALLING
- ELECTRICITY LINE UNDER GROUND
- ELECTRICITY LINE MINOR OVERHEAD
- ELECTRICITY LINE MAJOR OVERHEAD
- ELECTRICITY LINE OPTUS OVERHEAD
- SEWER MAIN
- OPEN DRAIN
- STAY POLE / ELECTRICAL POLE / LIGHT POLE
- EXISTING POLE TO BE RELOCATED
- PROPOSED POTHOLING LOCATION (INDICATIVE)
- EXISTING UTILITY TO BE DEMOLISHED
- EXISTING DRAINAGE TO BE DEMOLISHED

**PROPOSED**

- WATER MAIN
- GAS MAIN
- STORM WATER DRAINAGE PIPE / PIT
- STORM WATER DRAINAGE PIPE (ASSUMED)
- COMBINED TELSTRA & NBN CONDUIT
- TELECOMMUNICATIONS LINE
- TRAFFIC SIGNALLING
- ELECTRICITY LINE UNDER GROUND
- ELECTRICITY LINE MINOR OVERHEAD
- ELECTRICITY LINE MAJOR OVERHEAD
- ELECTRICITY LINE OPTUS OVERHEAD
- SEWER MAIN
- OPEN DRAIN
- STAY POLE / ELECTRICAL POLE / LIGHT POLE
- EXISTING POLE TO BE RELOCATED
- PROPOSED POTHOLING LOCATION (INDICATIVE)

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

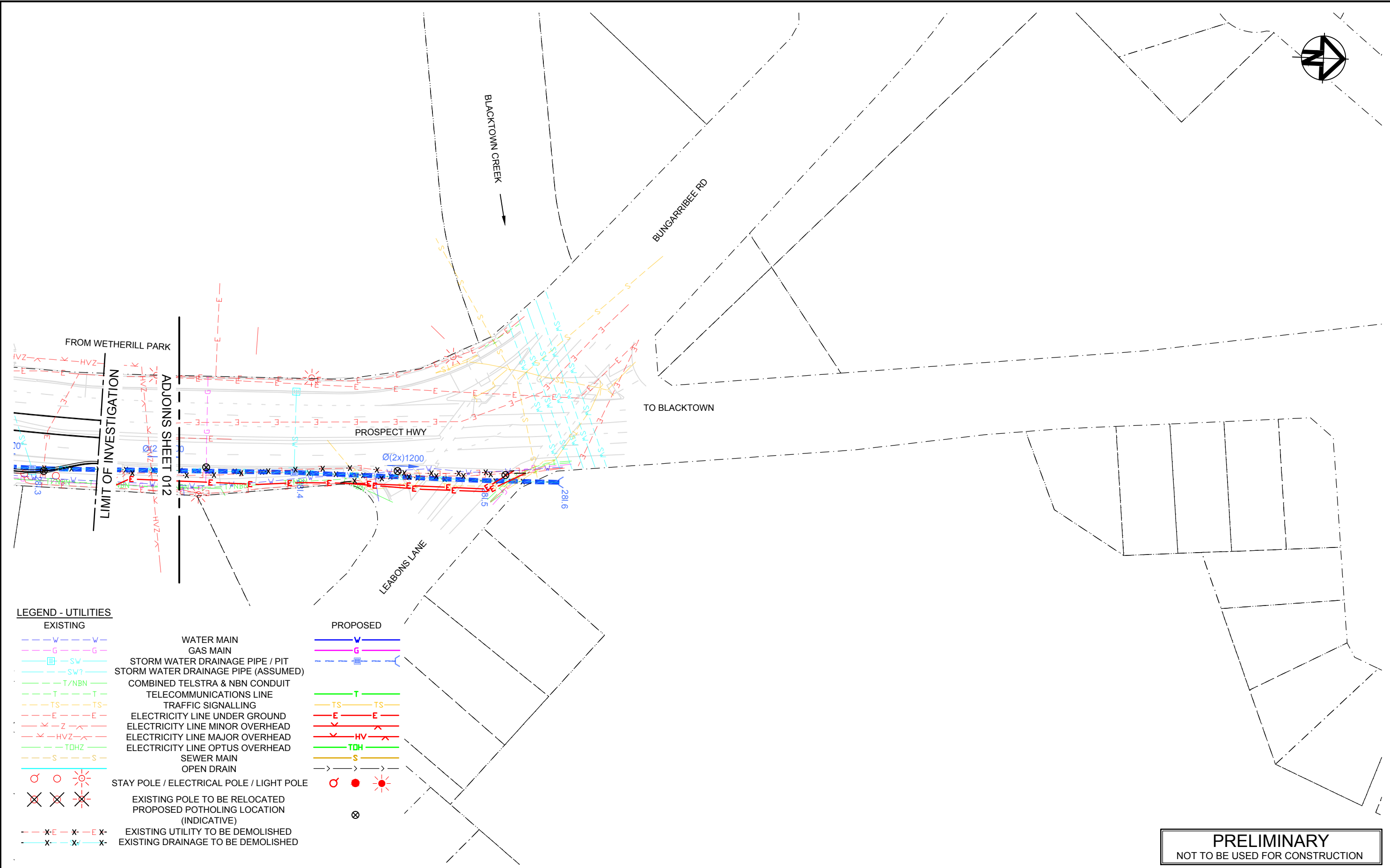


SCALE AT A3

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CONCEPT DRAINAGE DESIGN

SHEET 12 OF 15

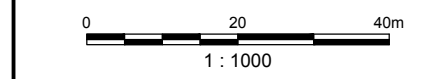


**LEGEND - UTILITIES**

- |                 |  |                 |  |
|-----------------|--|-----------------|--|
| <b>EXISTING</b> |  | <b>PROPOSED</b> |  |
| —W—W—           | WATER MAIN                               | —V—             | WATER MAIN                               |
| —G—G—           | GAS MAIN                                 | —G—             | GAS MAIN                                 |
| —SW—            | STORM WATER DRAINAGE PIPE / PIT          | —T—             | STORM WATER DRAINAGE PIPE / PIT          |
| —SW?            | STORM WATER DRAINAGE PIPE (ASSUMED)      | —TS—TS—         | STORM WATER DRAINAGE PIPE (ASSUMED)      |
| —T/NBN—         | COMBINED TELSTRA & NBN CONDUIT           | —E—E—           | COMBINED TELSTRA & NBN CONDUIT           |
| —T—T—           | TELECOMMUNICATIONS LINE                  | —HV—HV—         | TELECOMMUNICATIONS LINE                  |
| —TS—TS—         | TRAFFIC SIGNALLING                       | —TDH—           | TRAFFIC SIGNALLING                       |
| —E—E—           | ELECTRICITY LINE UNDER GROUND            | —S—S—           | ELECTRICITY LINE UNDER GROUND            |
| —Z—Z—           | ELECTRICITY LINE MINOR OVERHEAD          | —>—>—           | ELECTRICITY LINE MINOR OVERHEAD          |
| —HVZ—HVZ—       | ELECTRICITY LINE MAJOR OVERHEAD          | —>—>—           | ELECTRICITY LINE MAJOR OVERHEAD          |
| —TDHZ—          | ELECTRICITY LINE OPTUS OVERHEAD          | —>—>—           | ELECTRICITY LINE OPTUS OVERHEAD          |
| —S—S—           | SEWER MAIN                               | —>—>—           | SEWER MAIN                               |
| —>—>—           | OPEN DRAIN                               | —>—>—           | OPEN DRAIN                               |
| ⊙ ⊙ ⊙           | STAY POLE / ELECTRICAL POLE / LIGHT POLE | ⊙ ⊙ ⊙           | STAY POLE / ELECTRICAL POLE / LIGHT POLE |
| ⊗ ⊗ ⊗           | EXISTING POLE TO BE RELOCATED            | ⊗ ⊗ ⊗           | EXISTING POLE TO BE RELOCATED            |
| ⊗ ⊗ ⊗           | PROPOSED POTHOLING LOCATION (INDICATIVE) | ⊗ ⊗ ⊗           | PROPOSED POTHOLING LOCATION (INDICATIVE) |
| —x—E—x—E—x—     | EXISTING UTILITY TO BE DEMOLISHED        |                 |  |
| —x—S—x—S—x—     | EXISTING DRAINAGE TO BE DEMOLISHED       |                 |  |

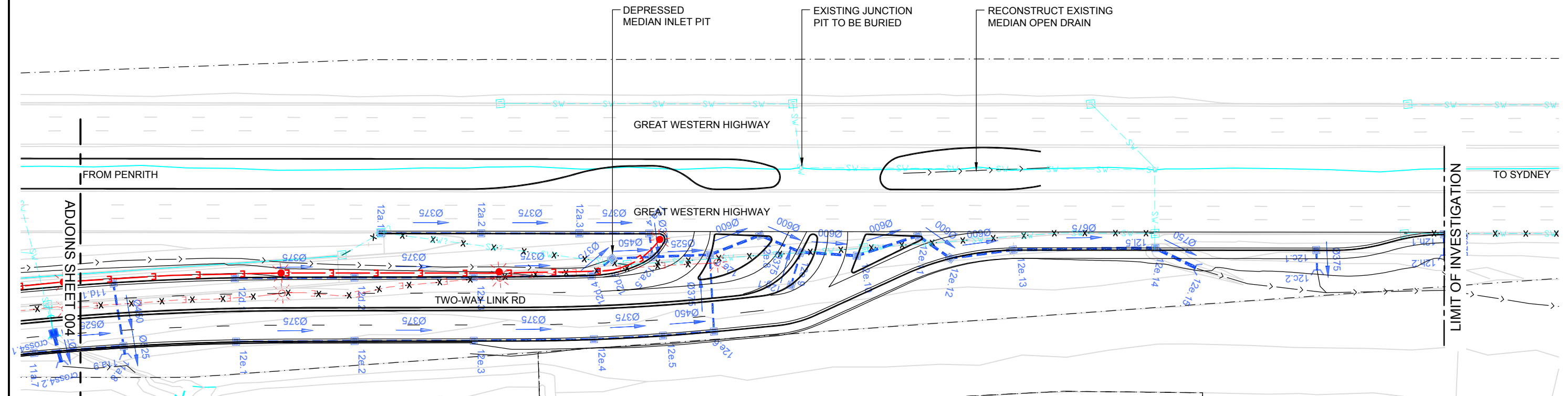
**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

CONCEPT DRAINAGE DESIGN





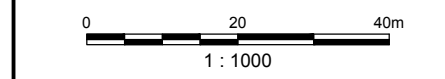




LEGEND - UTILITIES	
<b>EXISTING</b>	
	WATER MAIN
	GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN
	OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)
	EXISTING UTILITY TO BE DEMOLISHED
	EXISTING DRAINAGE TO BE DEMOLISHED
<b>PROPOSED</b>	
	WATER MAIN
	GAS MAIN
	STORM WATER DRAINAGE PIPE / PIT
	STORM WATER DRAINAGE PIPE (ASSUMED)
	COMBINED TELSTRA & NBN CONDUIT
	TELECOMMUNICATIONS LINE
	TRAFFIC SIGNALLING
	ELECTRICITY LINE UNDER GROUND
	ELECTRICITY LINE MINOR OVERHEAD
	ELECTRICITY LINE MAJOR OVERHEAD
	ELECTRICITY LINE OPTUS OVERHEAD
	SEWER MAIN
	OPEN DRAIN
	STAY POLE / ELECTRICAL POLE / LIGHT POLE
	EXISTING POLE TO BE RELOCATED
	PROPOSED POTHOLING LOCATION (INDICATIVE)

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

CONCEPT DRAINAGE DESIGN



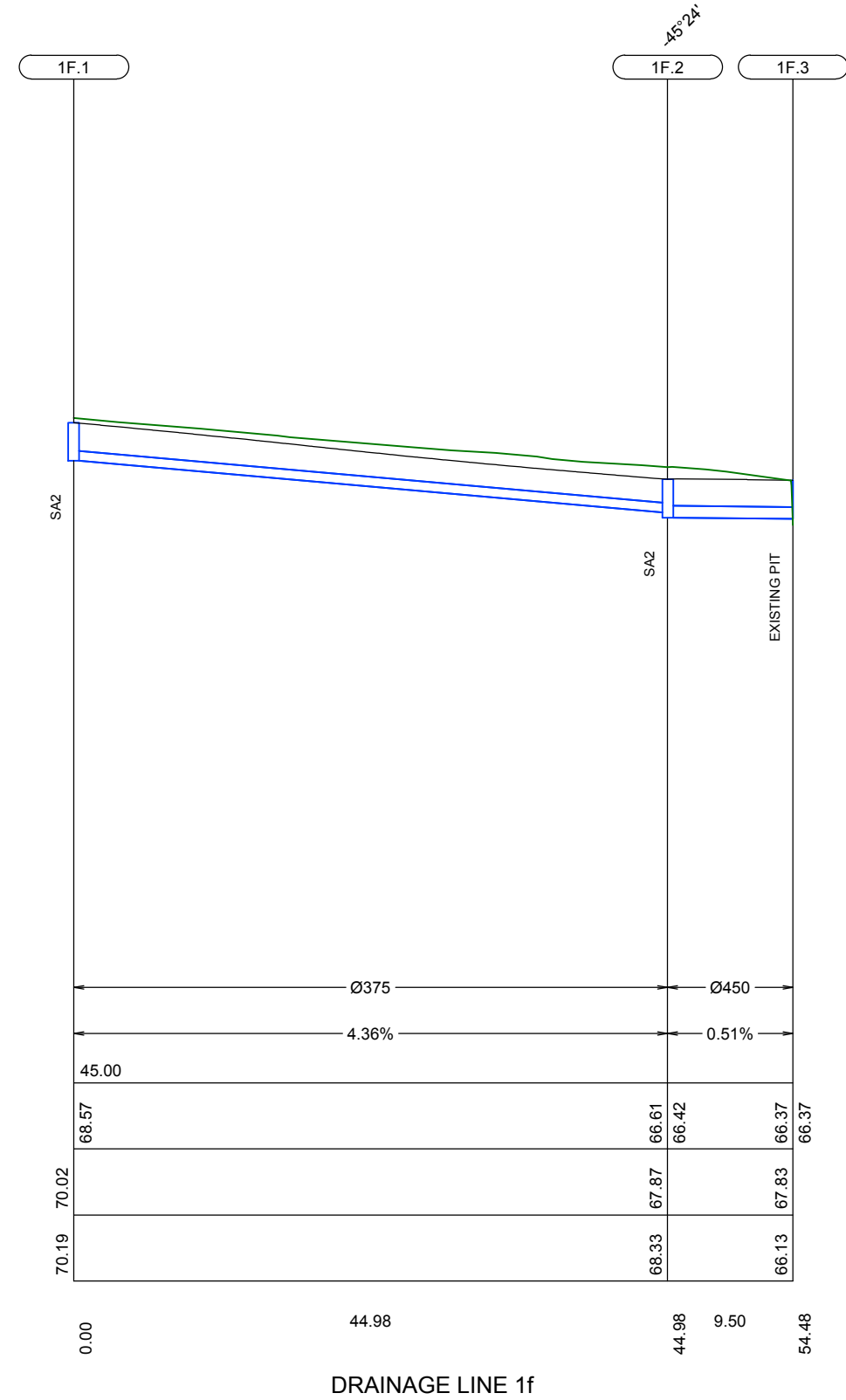
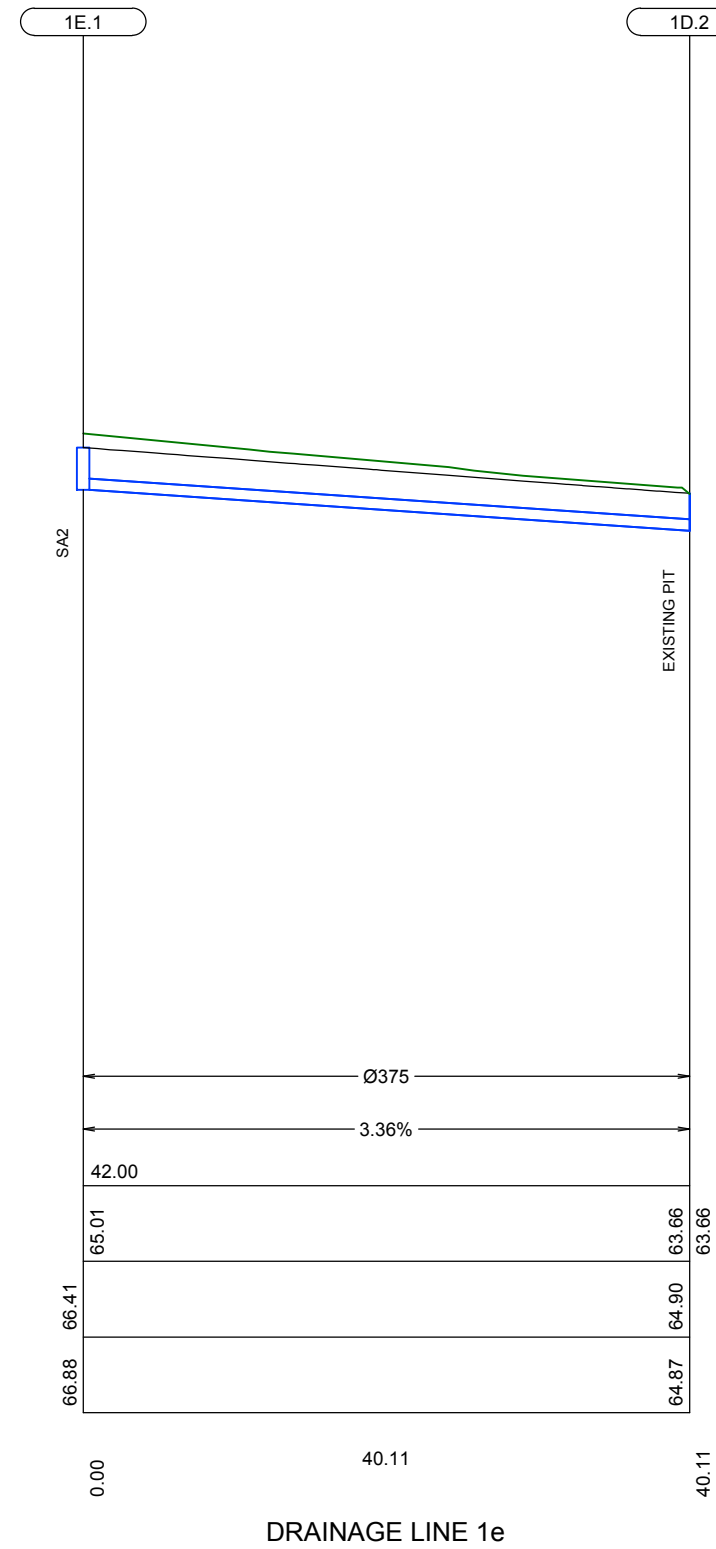
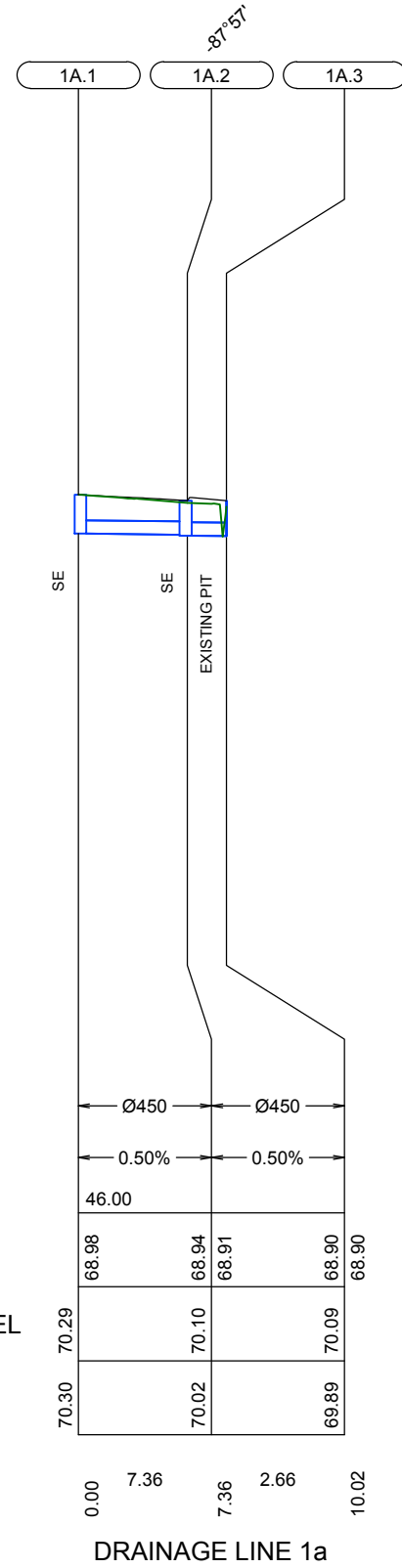
SHEET 15 OF 15

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

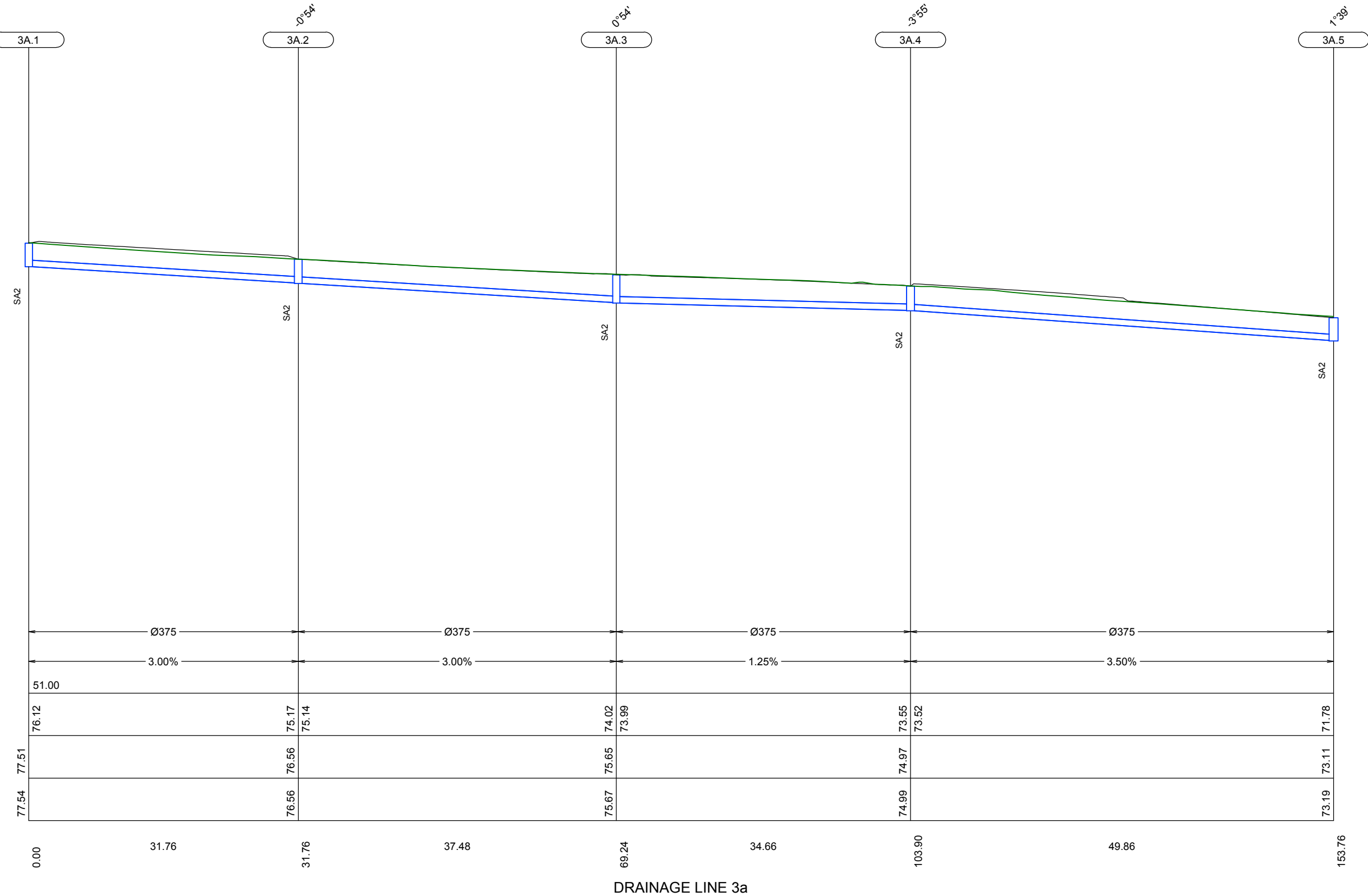
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Horizontal Scale 1:500  
at A3  
Sheet No. 1

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 3a

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

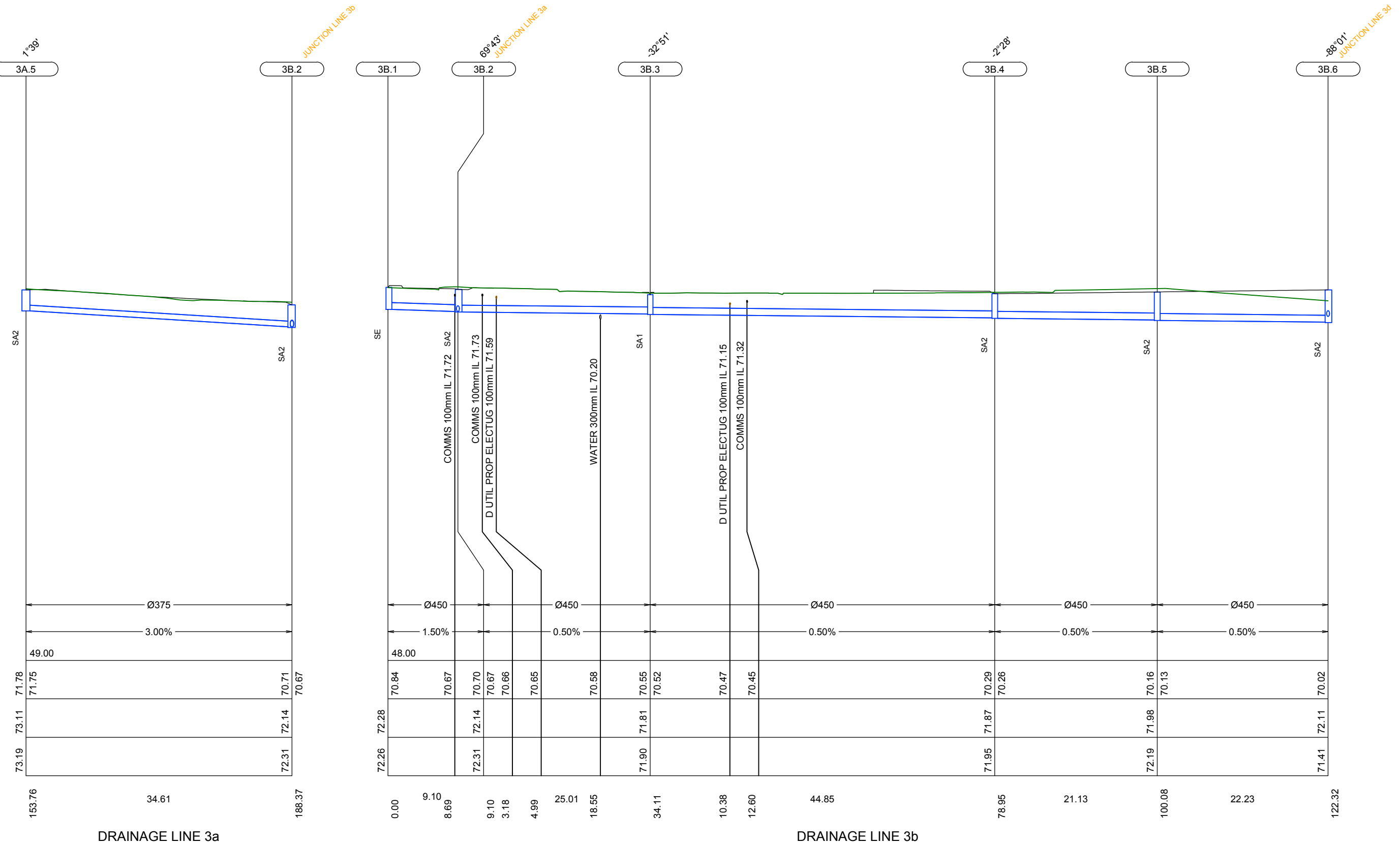
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Sheet No. 2  
at A3

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 3

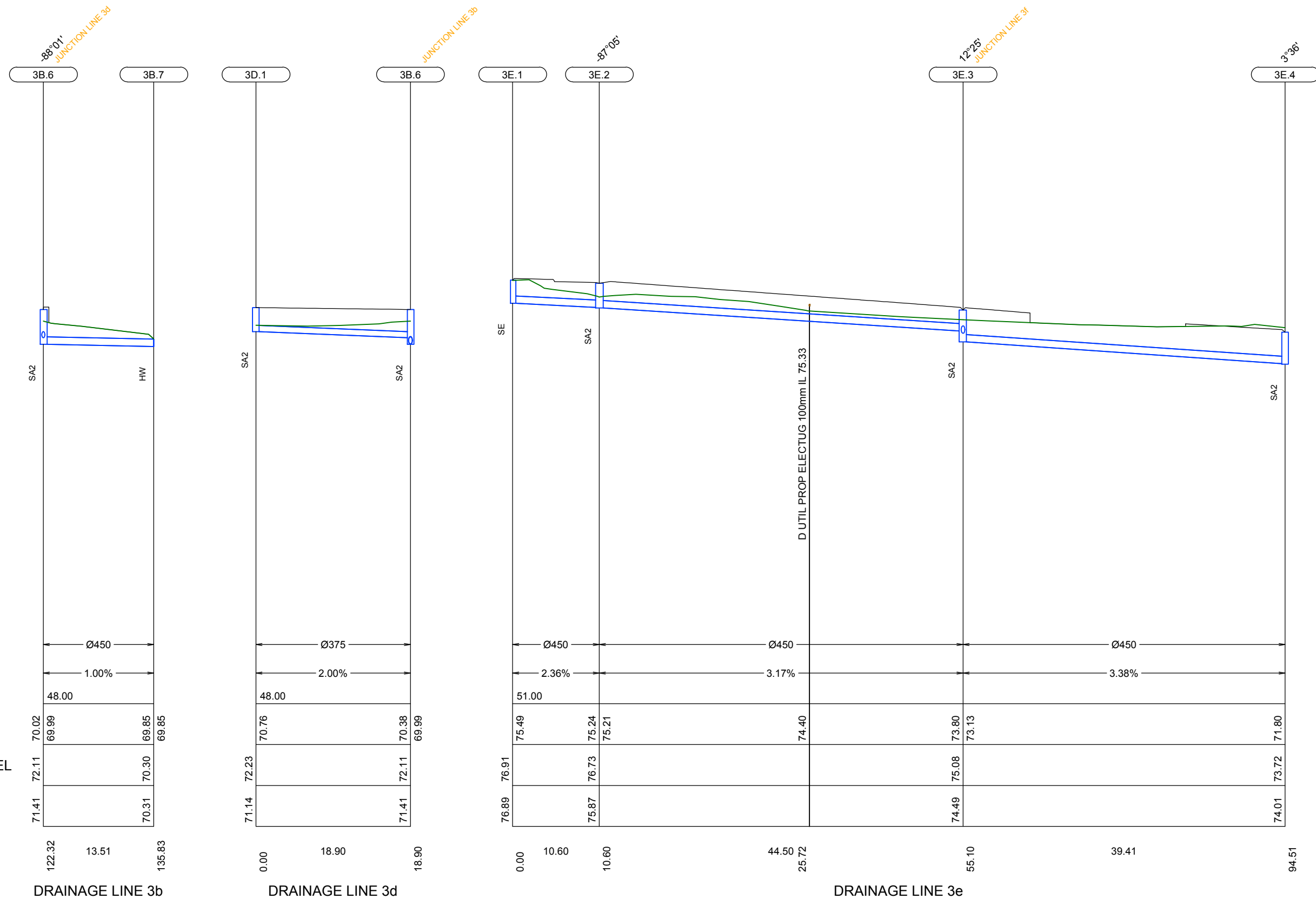


**NOTES:**

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2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
Sheet No. 4

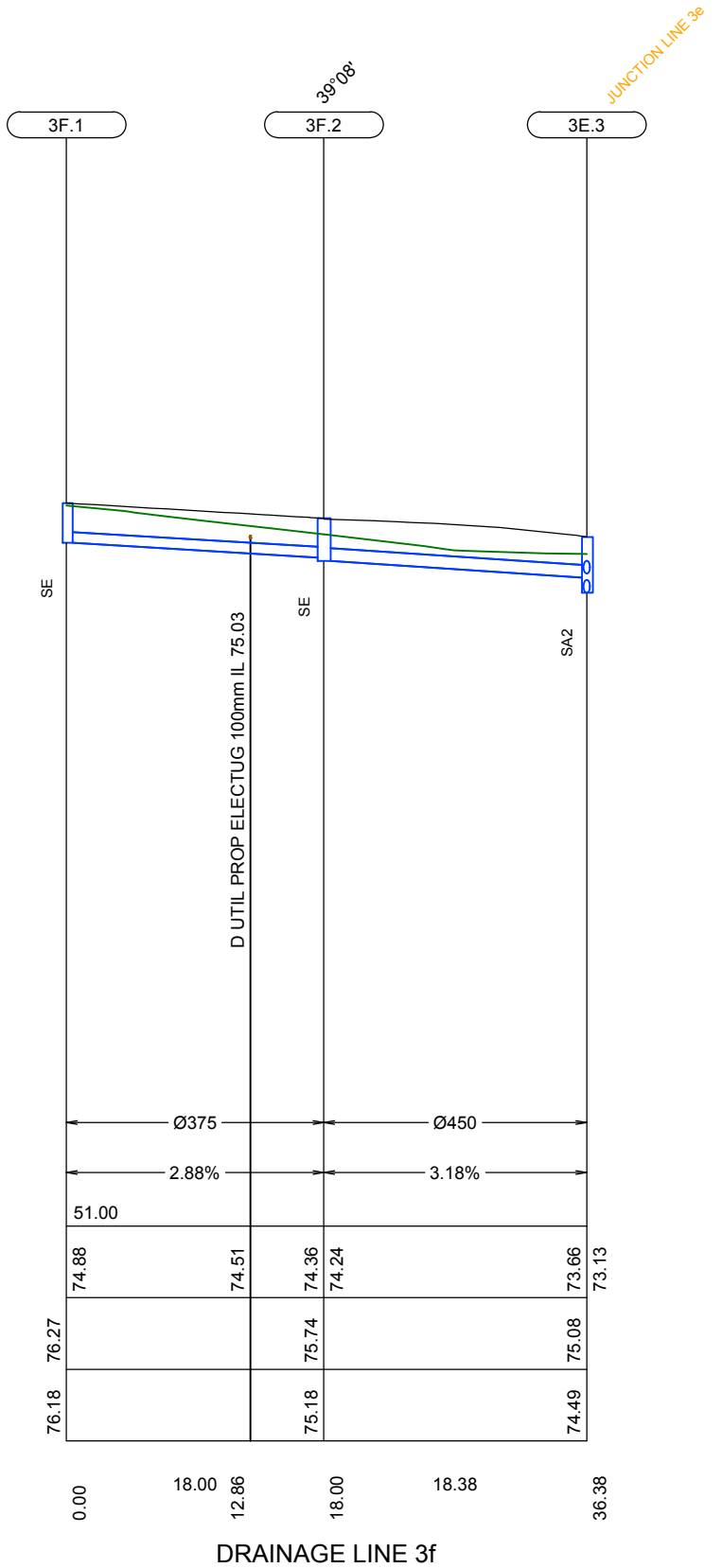
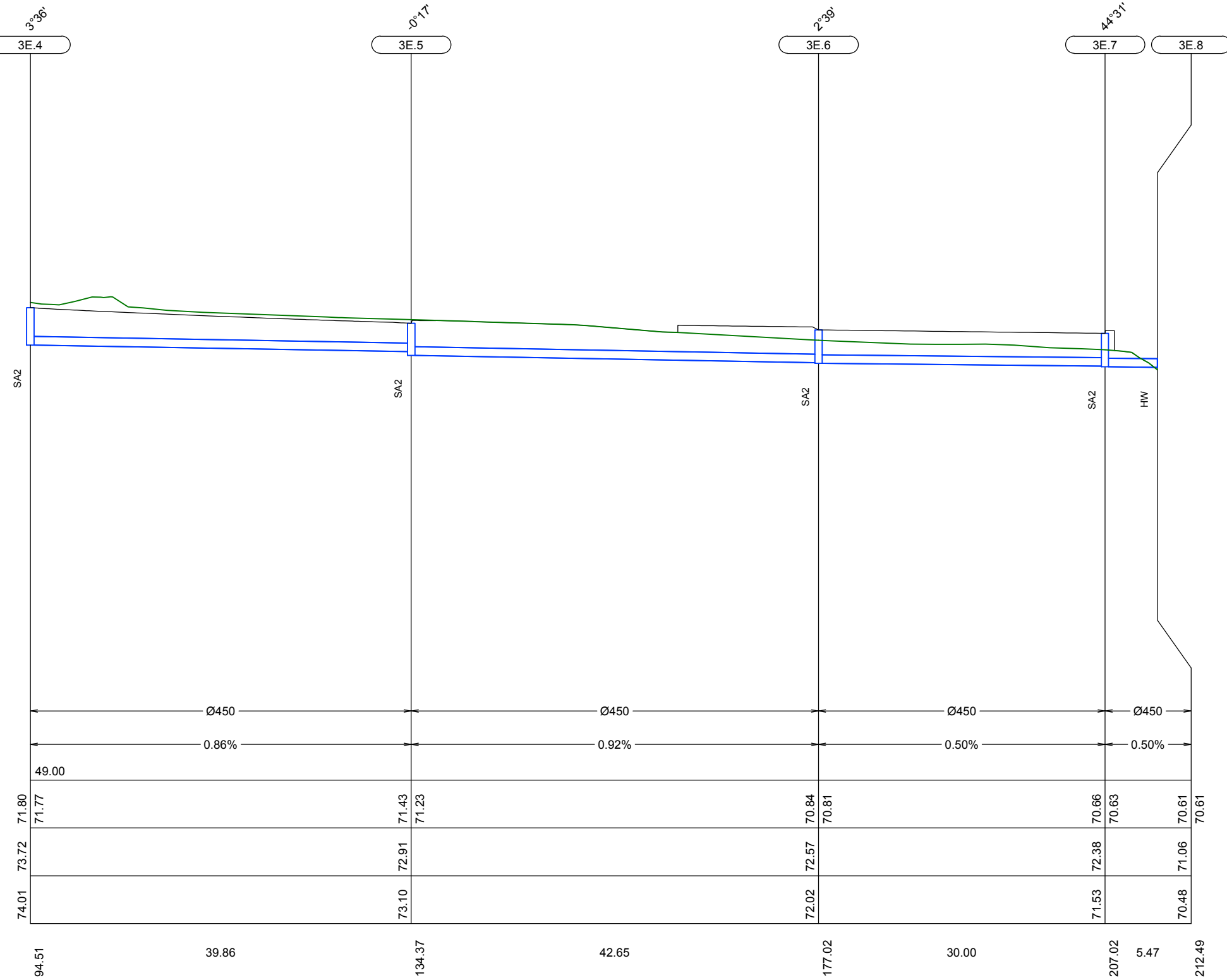
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**NOTES:**

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2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLES ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

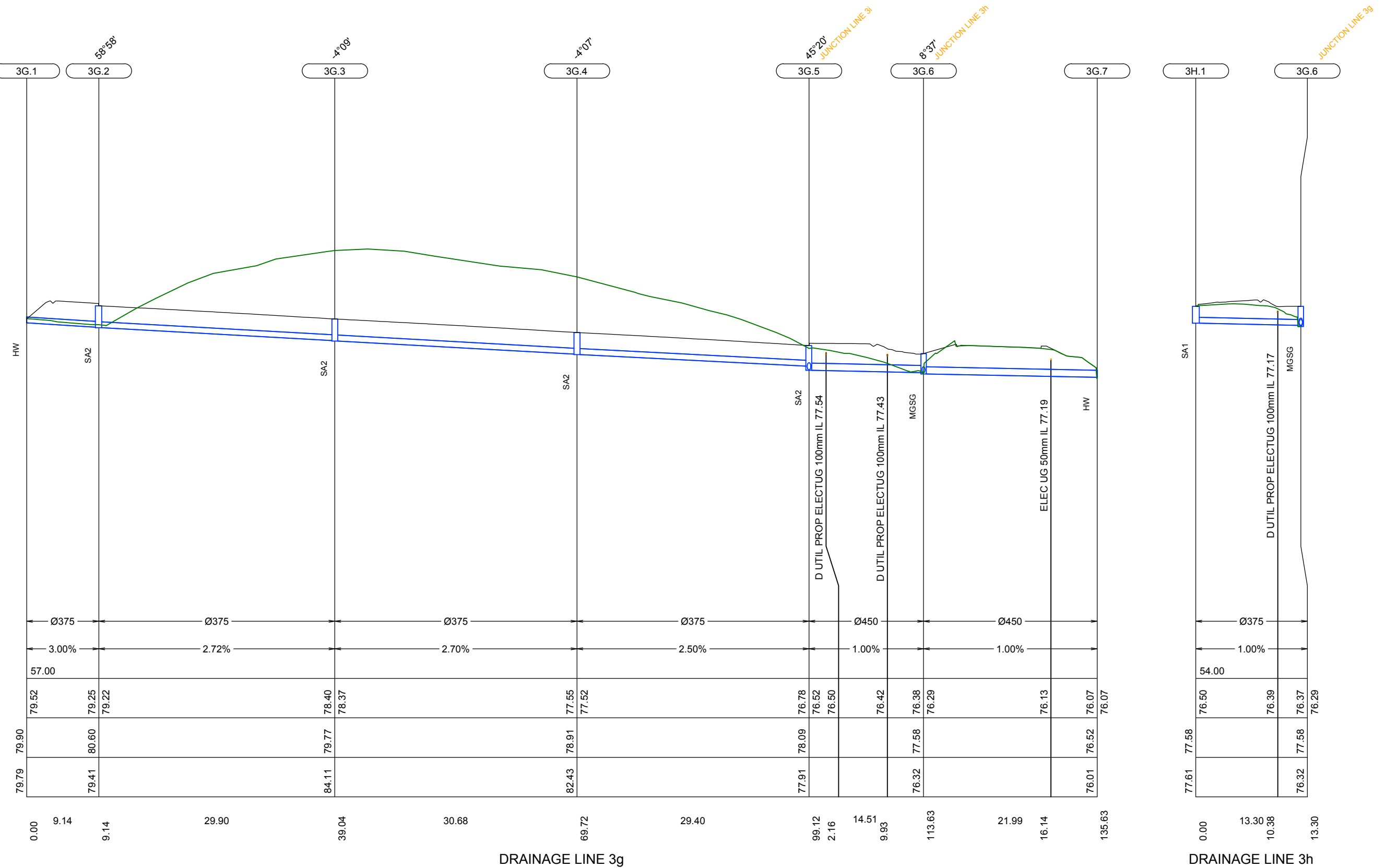
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Sheet No. 5

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

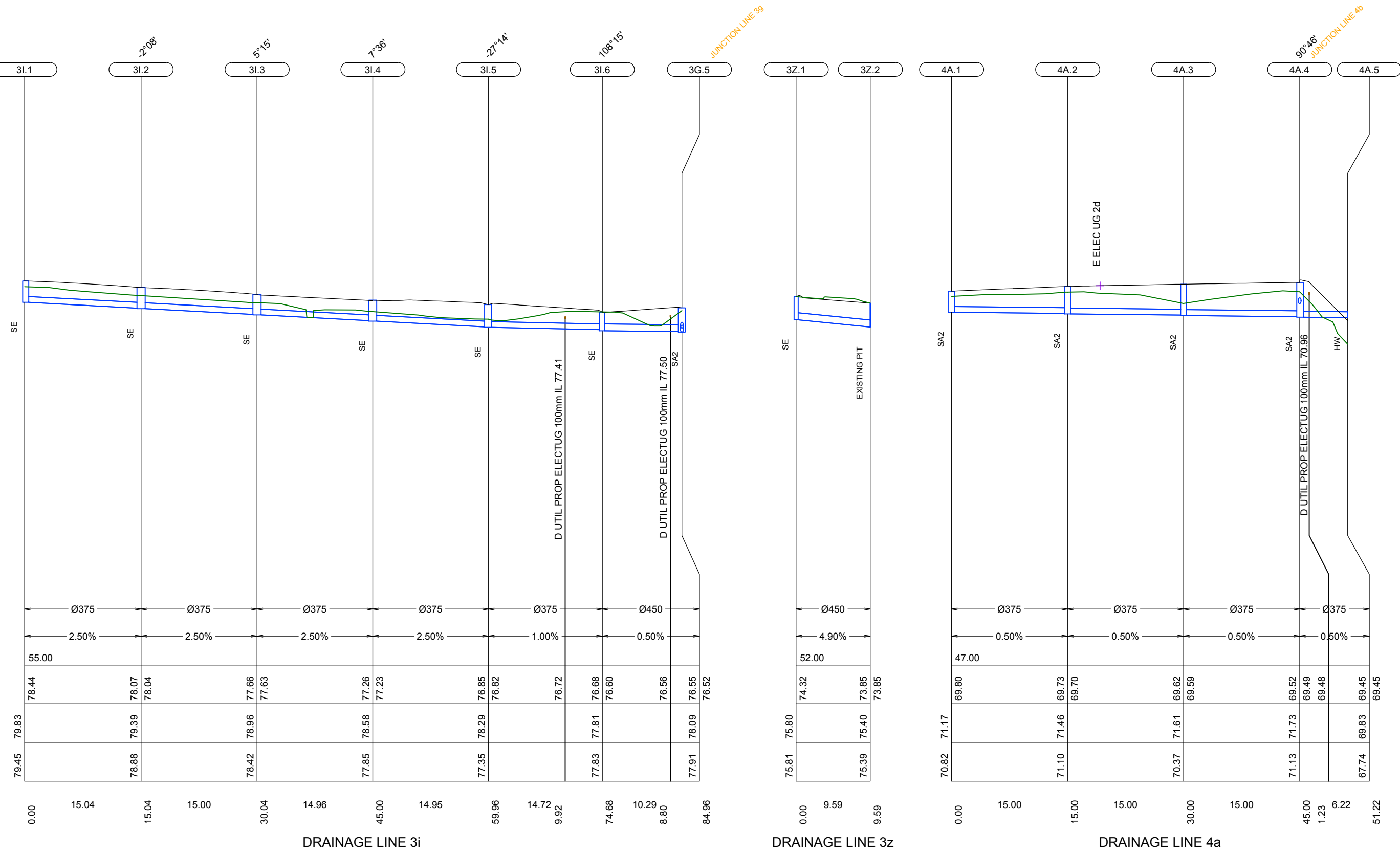
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Sheet No. 6

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 7

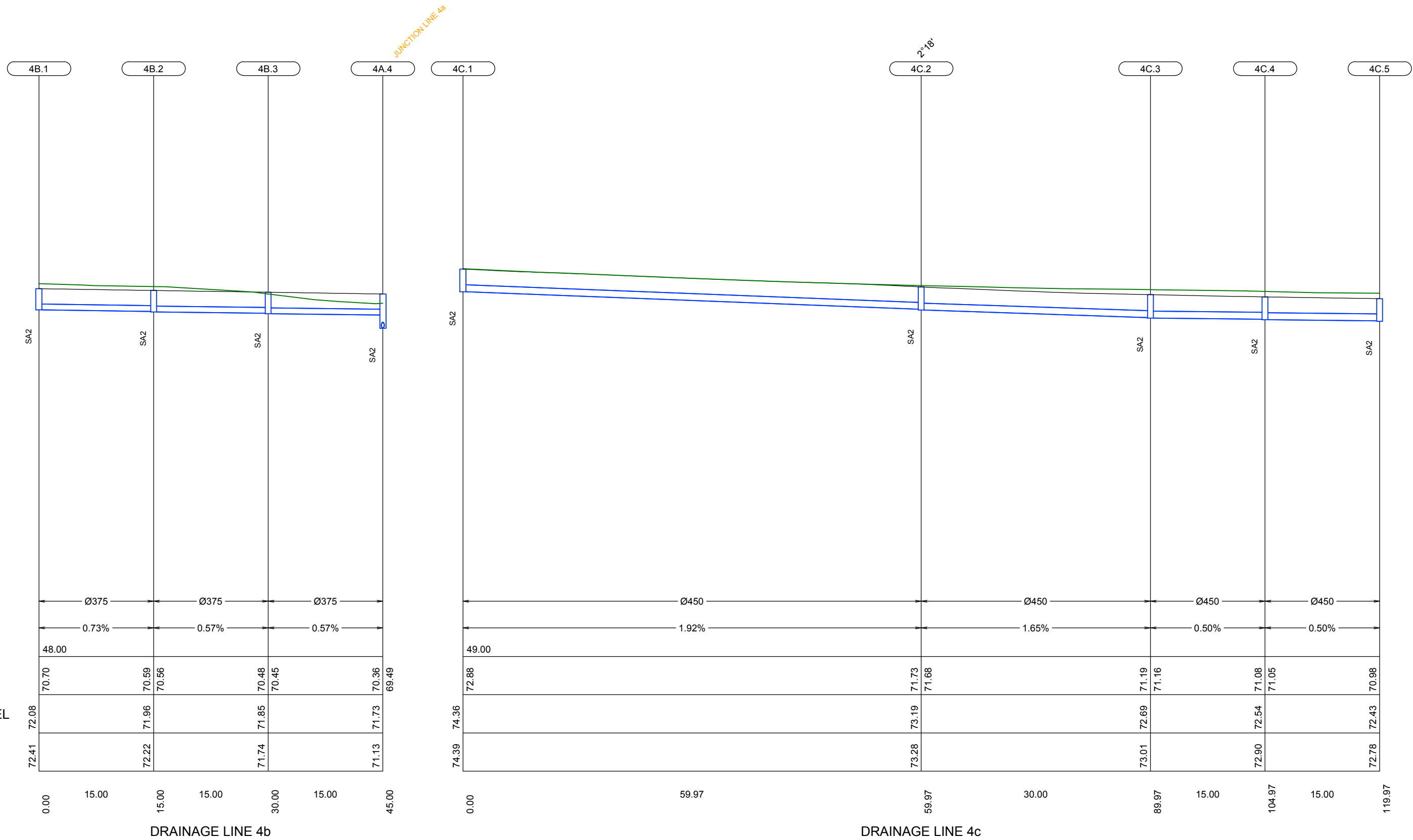


**NOTES:**

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2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



JUNCTION LINE 4a

2" x 18"

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

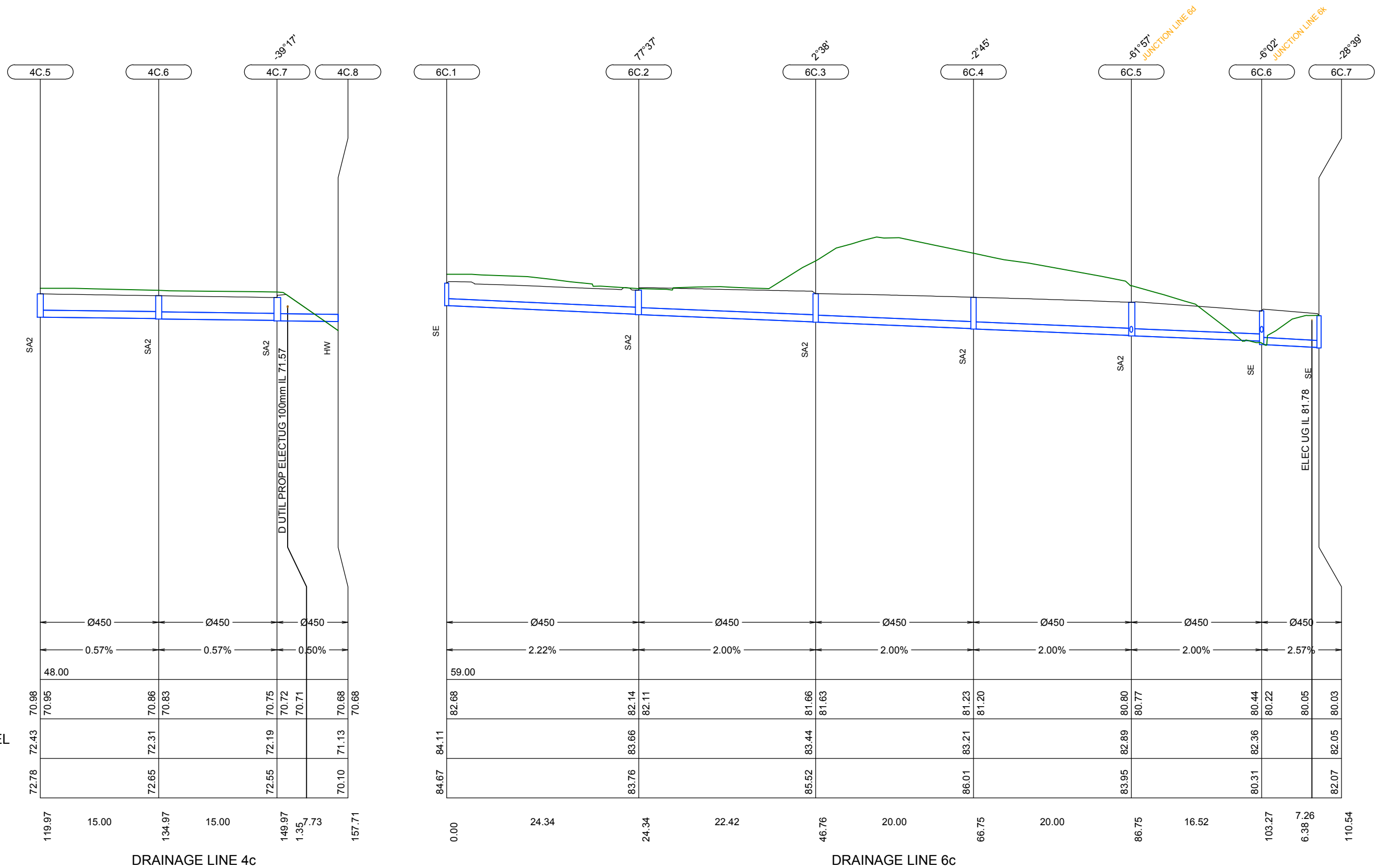
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**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



PIPE SIZE	Ø450	Ø450	Ø450
PIPE GRADIENT	0.57%		0.50%
DATUM R.L.	48.00		
INVERT LEVELS	70.98 70.95	70.86 70.83	70.75 70.72 70.71
PIT DESIGN LEVEL	72.43	72.31	72.19 71.13
EXISTING LEVEL	72.78	72.65	72.55 71.10
CHAINAGE AND PIPE LENGTH	119.97 15.00	134.97 15.00	149.97 1.35 7.73 157.71

PIPE SIZE	Ø450	Ø450	Ø450	Ø450	Ø450	Ø450	
PIPE GRADIENT	2.22%		2.00%		2.00%		2.57%
DATUM R.L.	59.00						
INVERT LEVELS	82.68 84.11	82.14 82.11	81.66 81.63	81.23 81.20	80.80 80.77	80.44 80.22	80.05 80.03
PIT DESIGN LEVEL	84.11	83.66	83.44	83.21	82.89	82.36	82.05
EXISTING LEVEL	84.67	83.76	85.52	86.01	83.95	80.31	82.07
CHAINAGE AND PIPE LENGTH	0.00 24.34	24.34 22.42	46.76 20.00	66.75 20.00	86.75 16.52	103.27 7.26	110.54

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 9

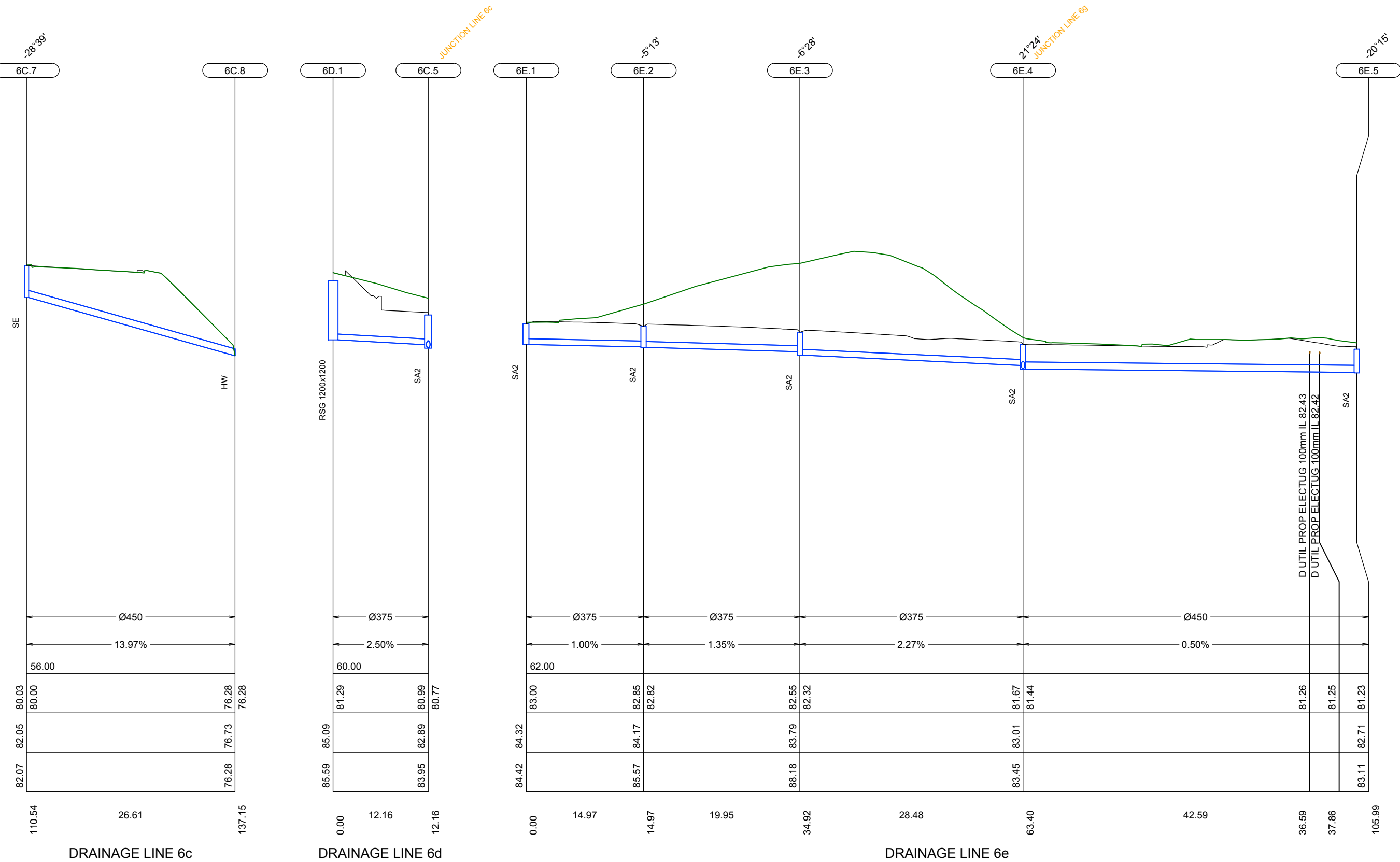


**NOTES:**

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2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

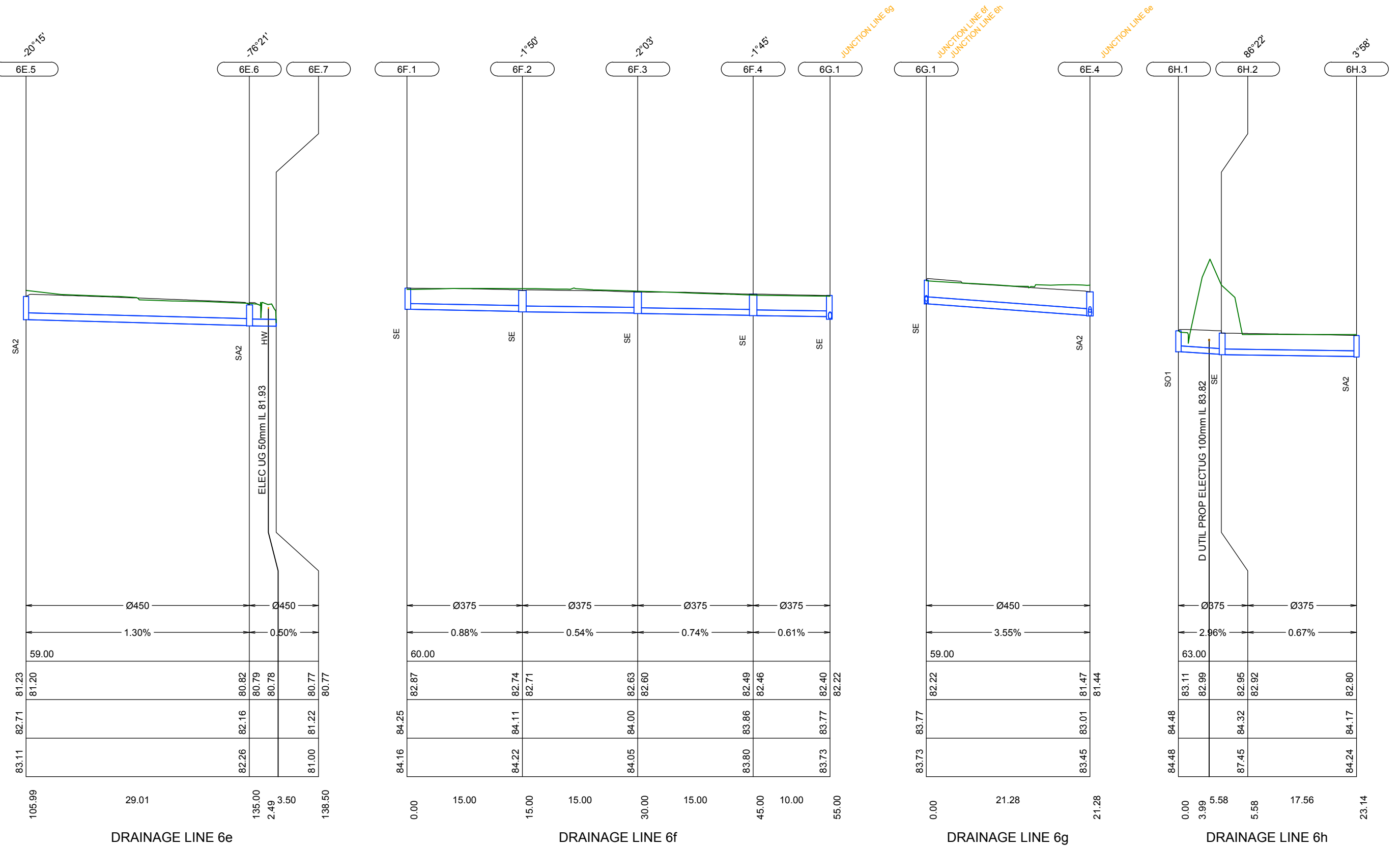
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at A3  
Sheet No. 10

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
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**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 11

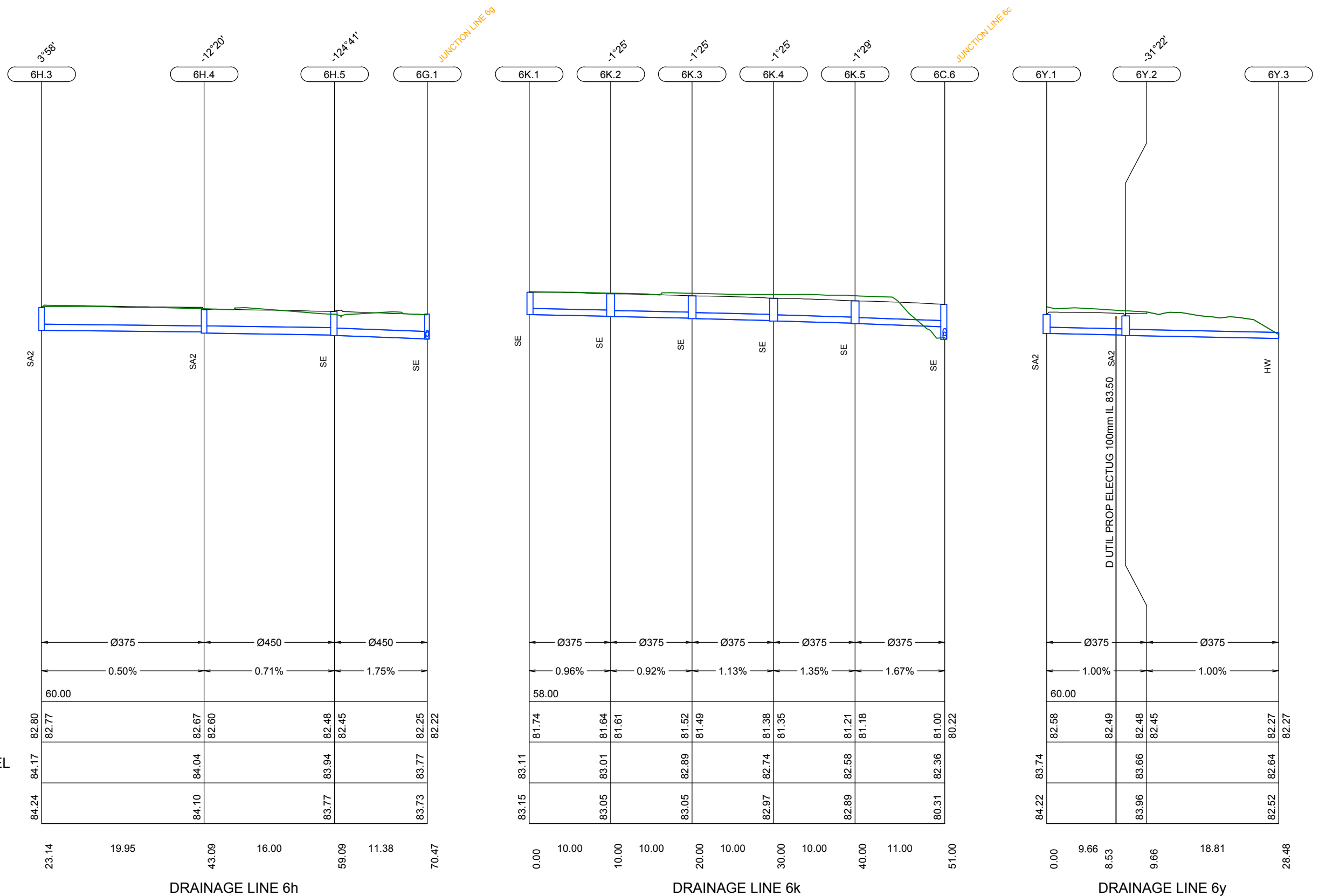


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

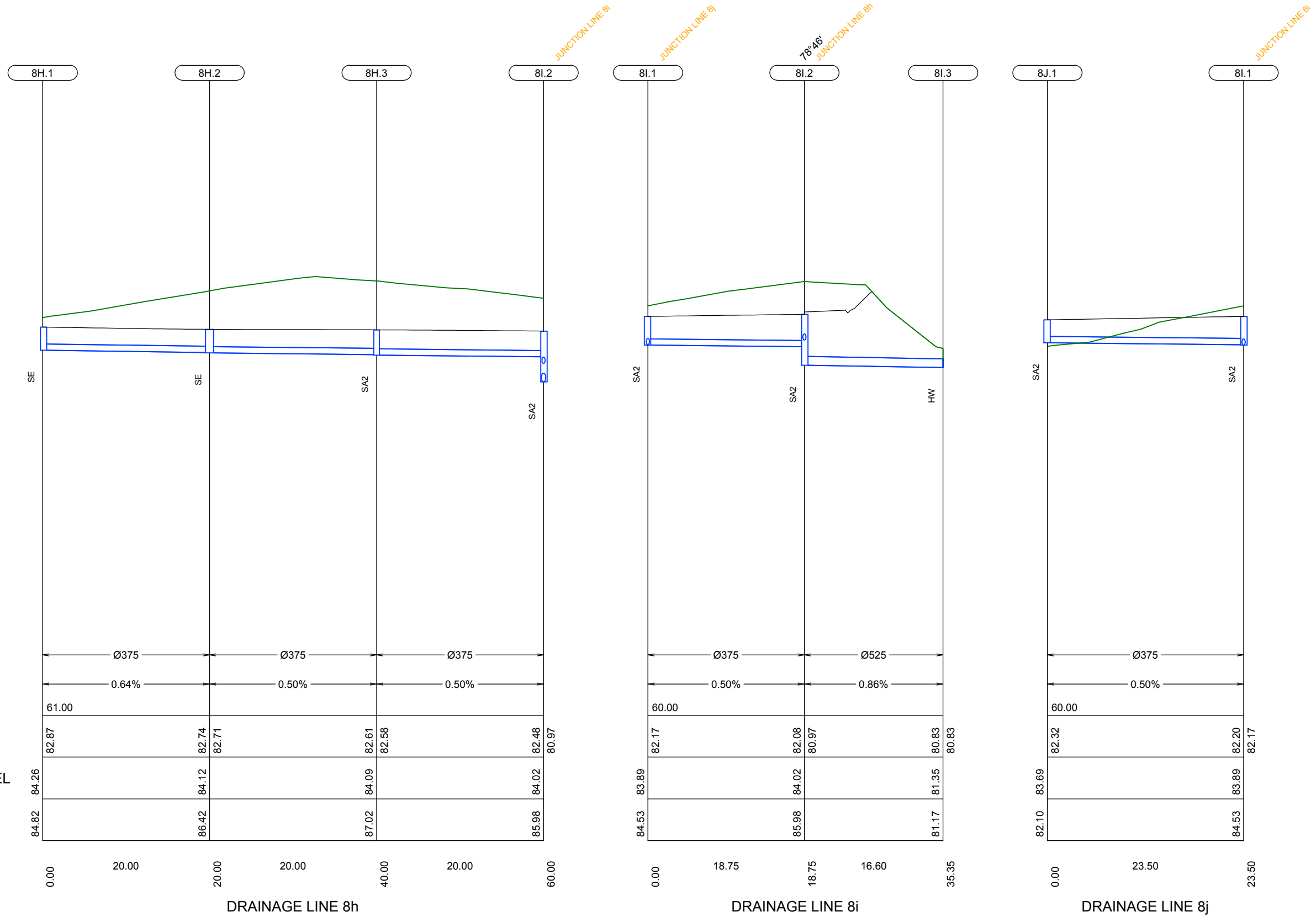
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Sheet No. 12  
at A3

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 13

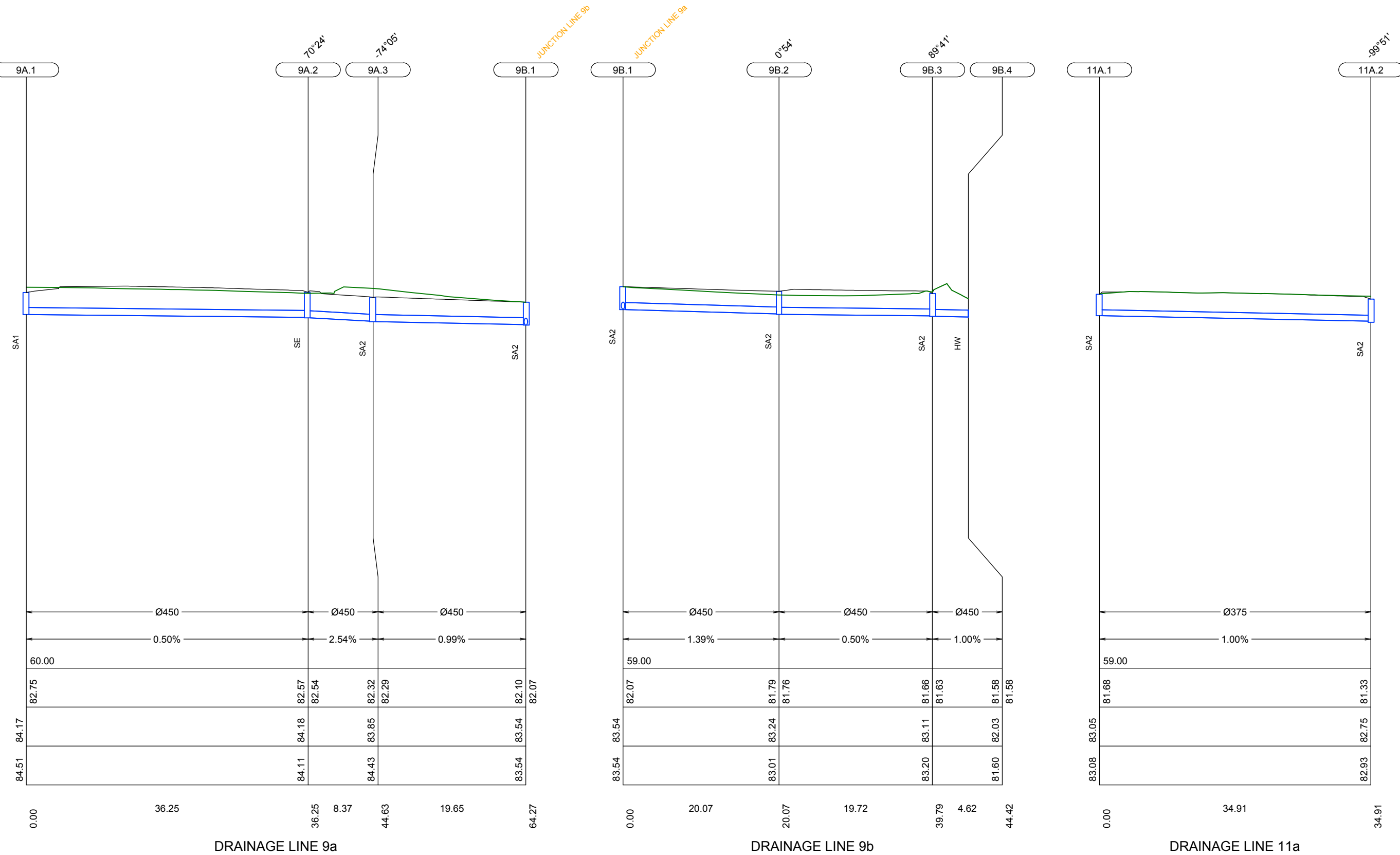


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

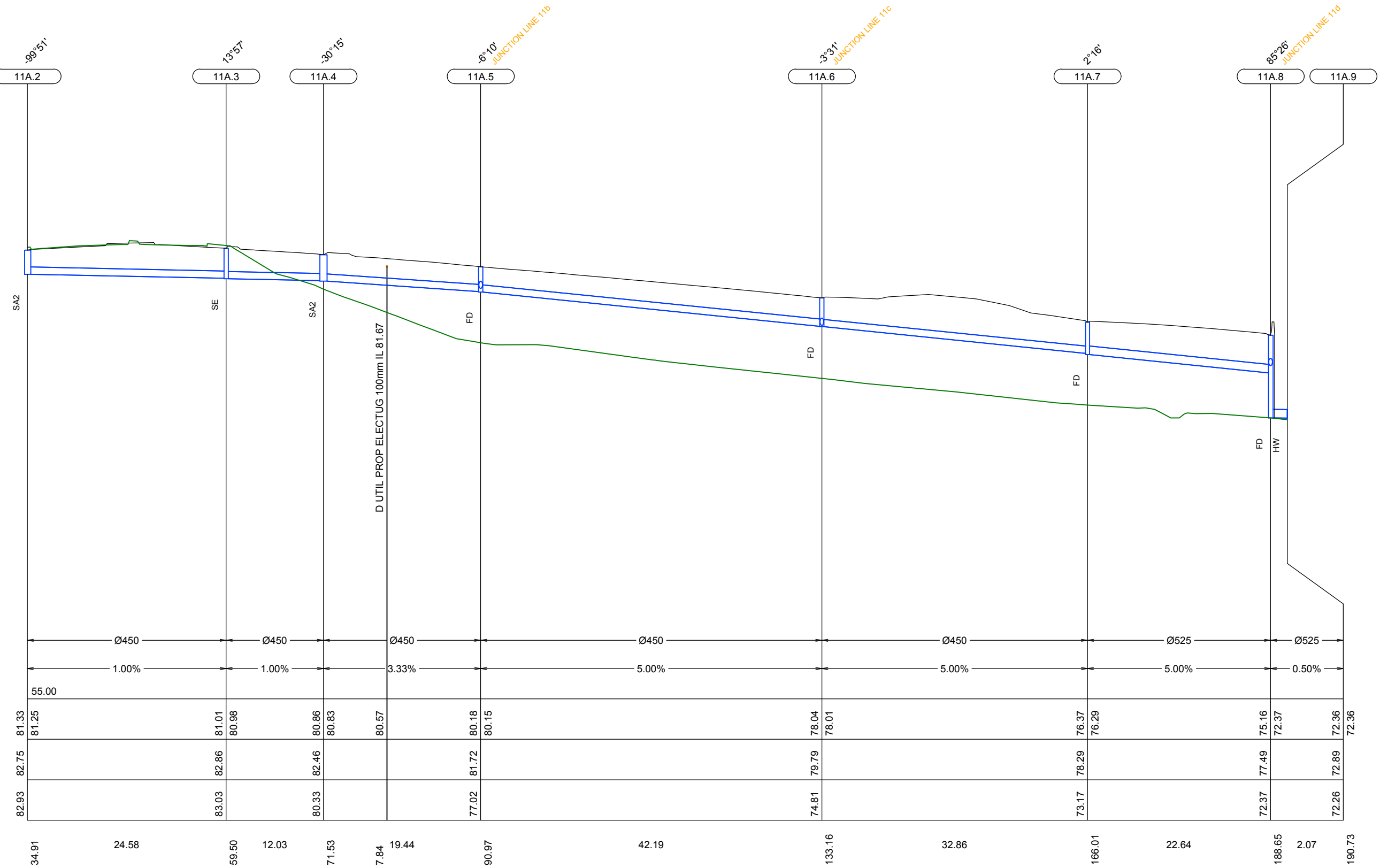
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Sheet No. 14

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 11a

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 15

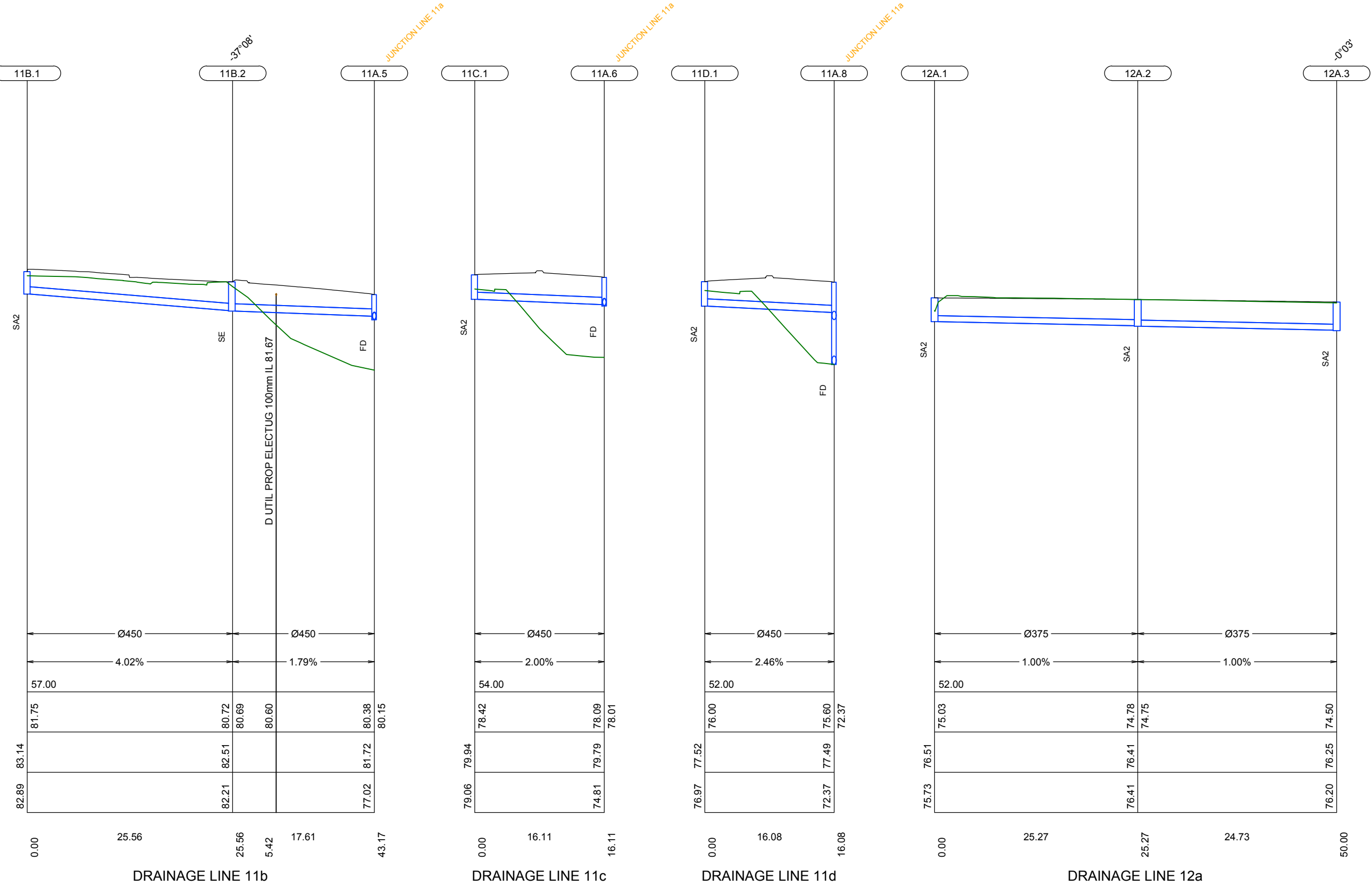


**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

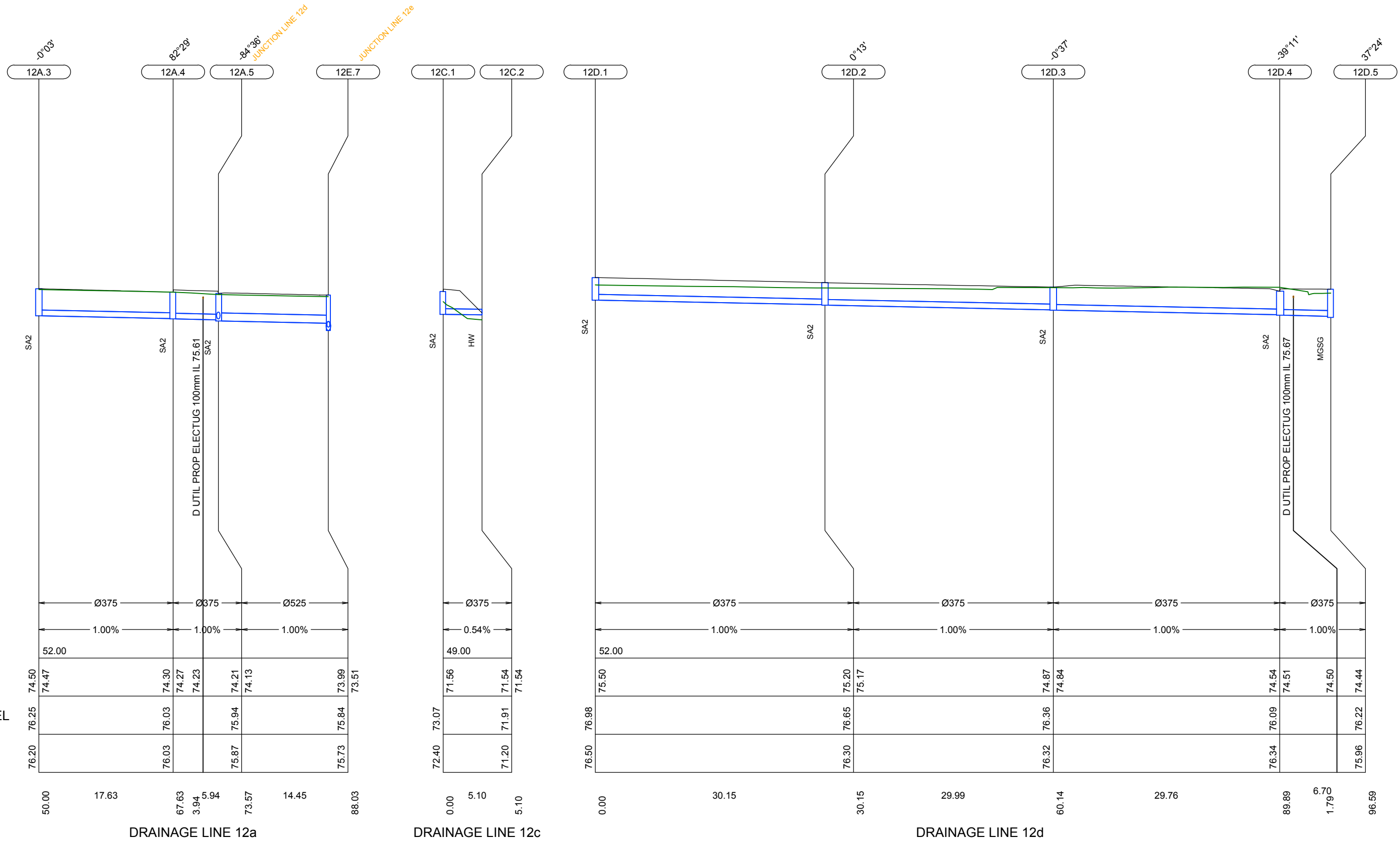
Sheet No. 16

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 17

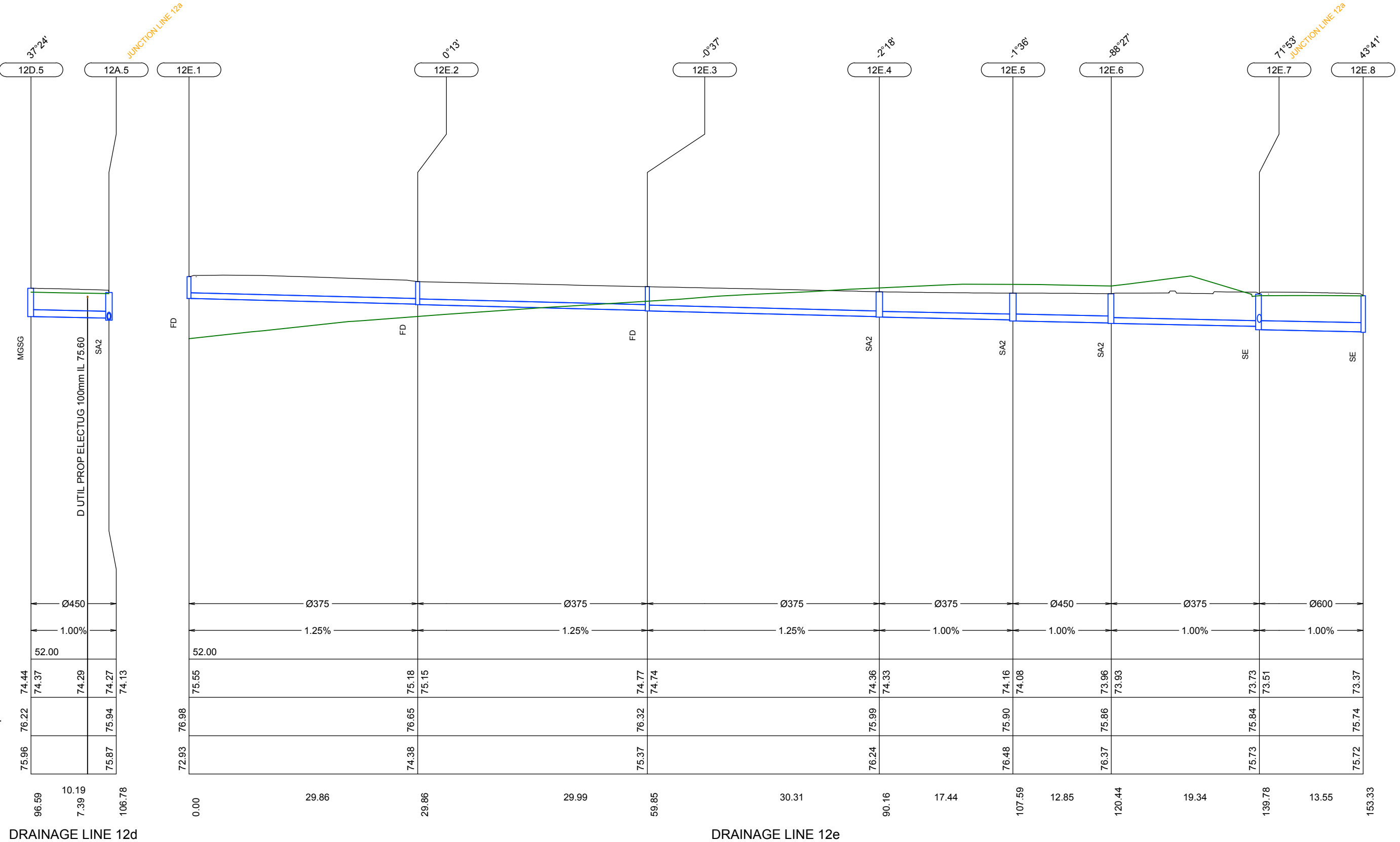


**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

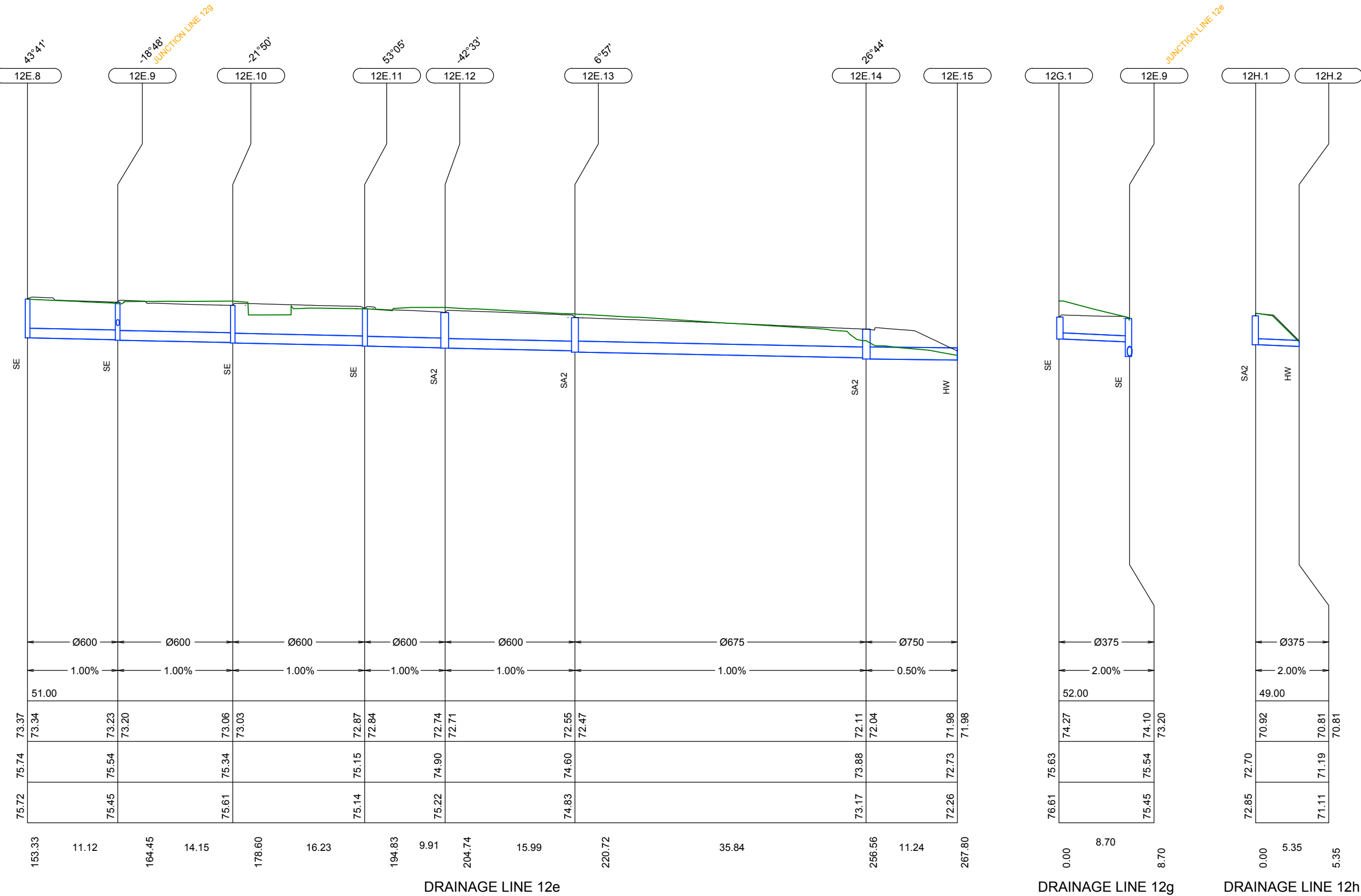
Sheet No. 18

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
Sheet No. 19  
at A3

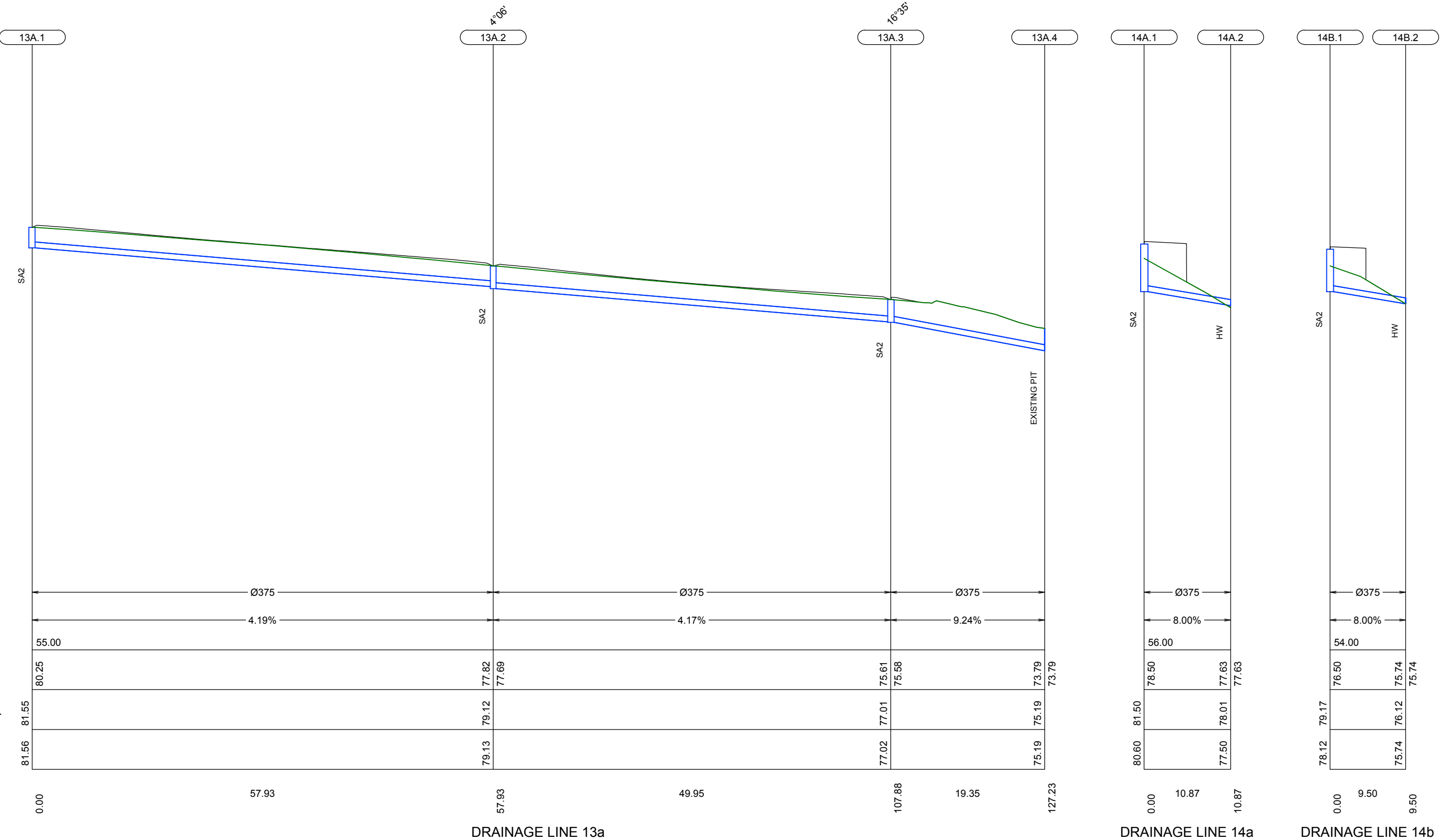


**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**



Vertical Scale 1:250  
Horizontal Scale 1:500  
Sheet No. 20

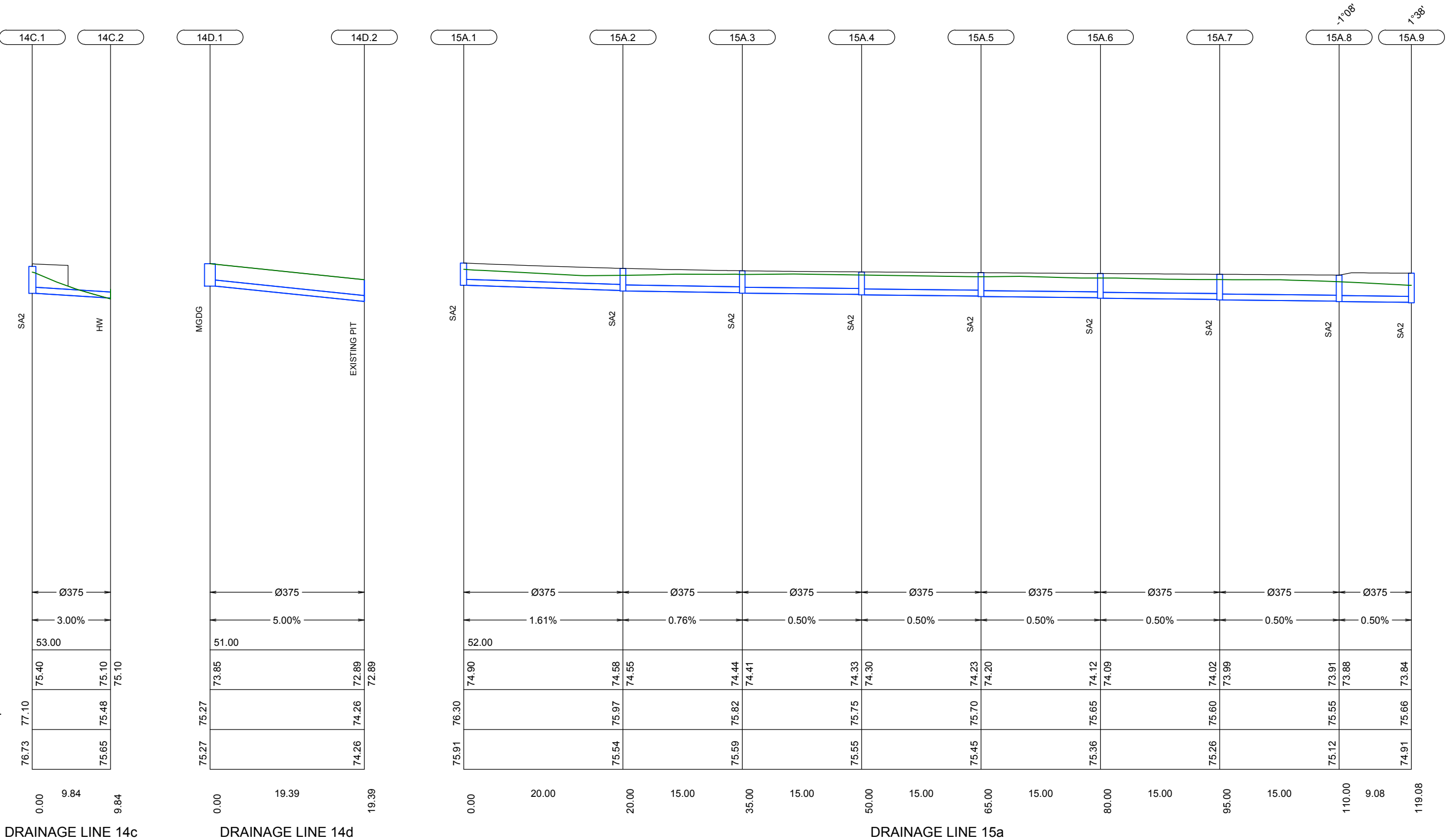
at A3

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

-  EXISTING SURFACE
-  DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 21

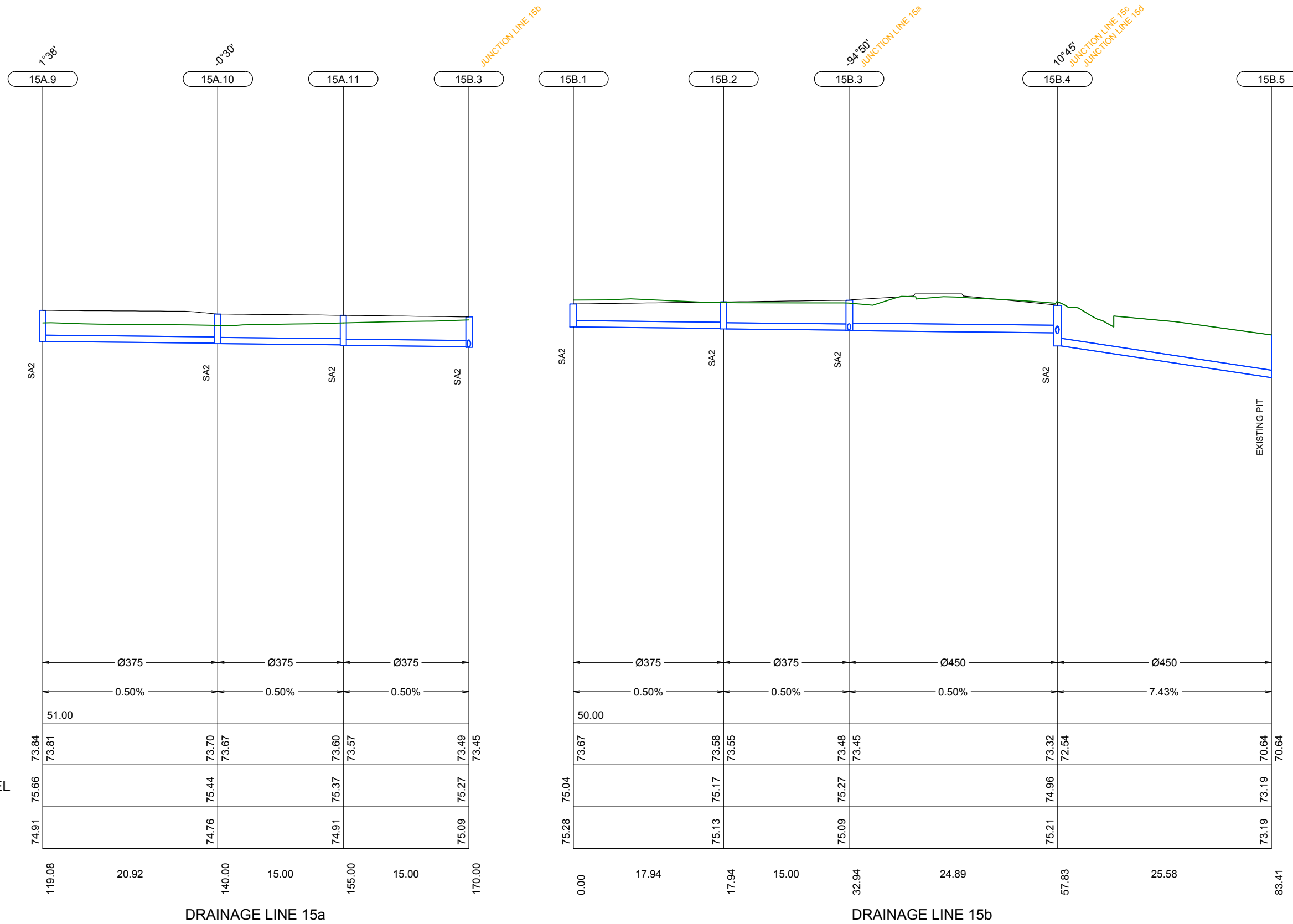


**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

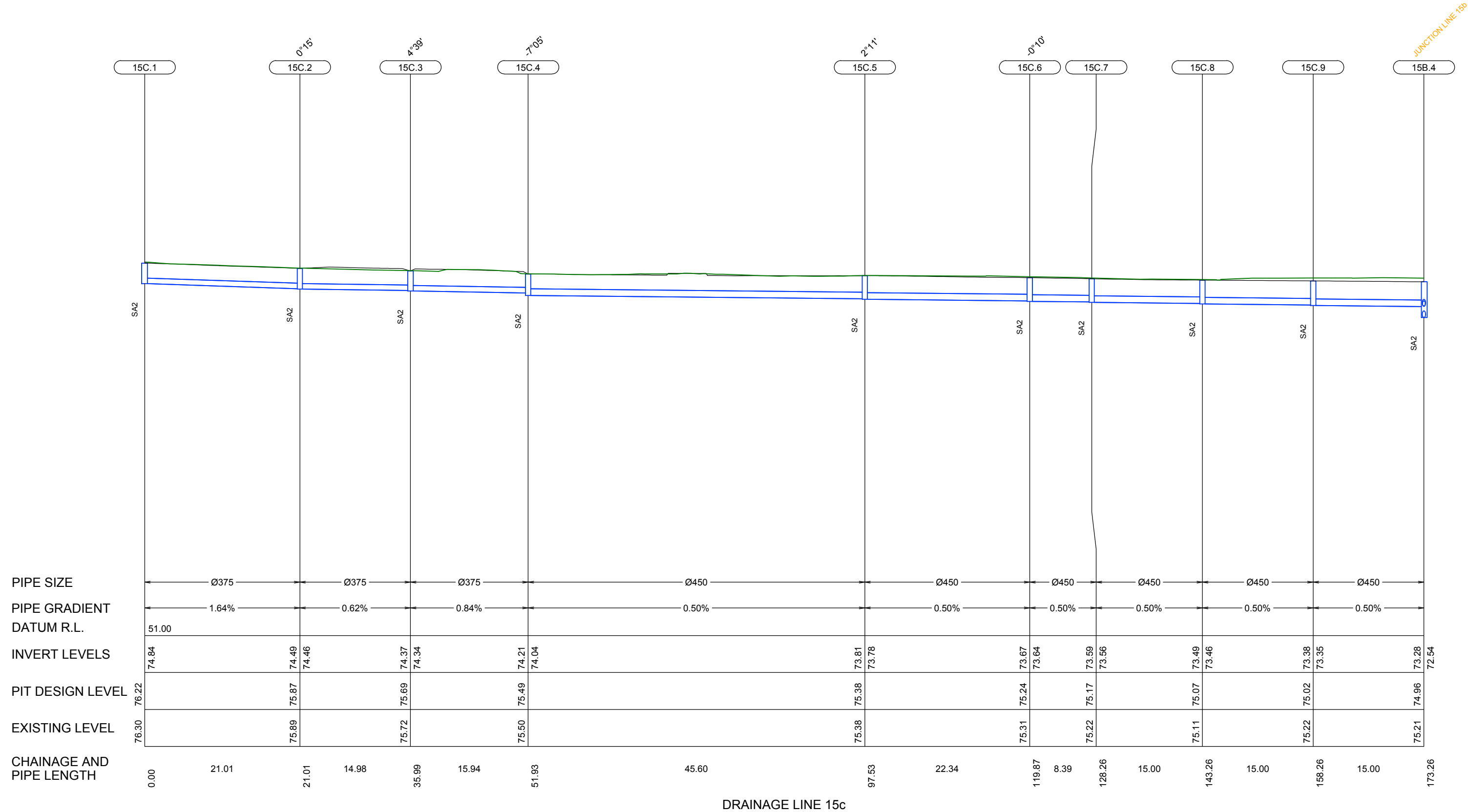
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Horizontal Scale 1:500  
Sheet No. 22  
at A3

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 15c

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 23

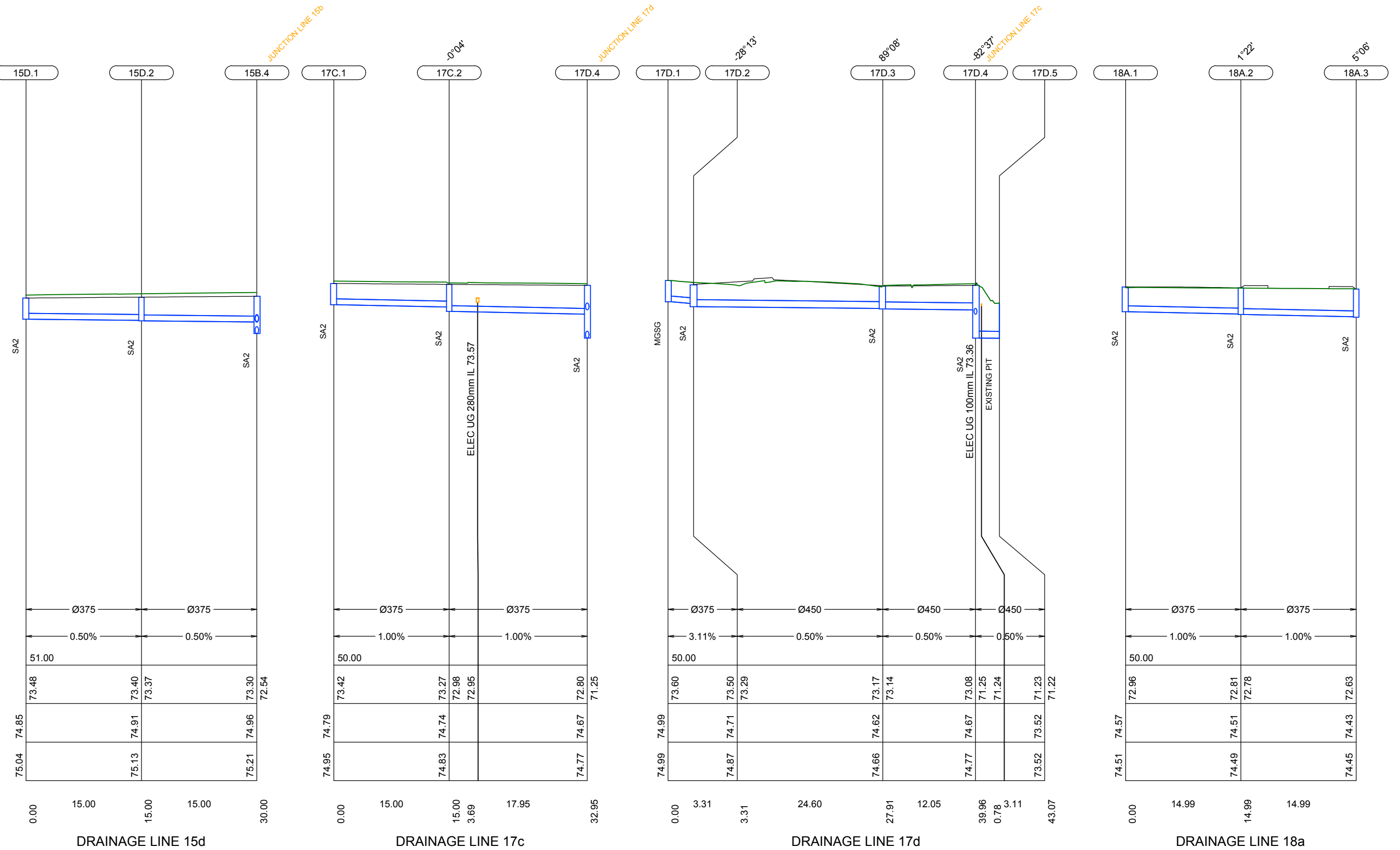


**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

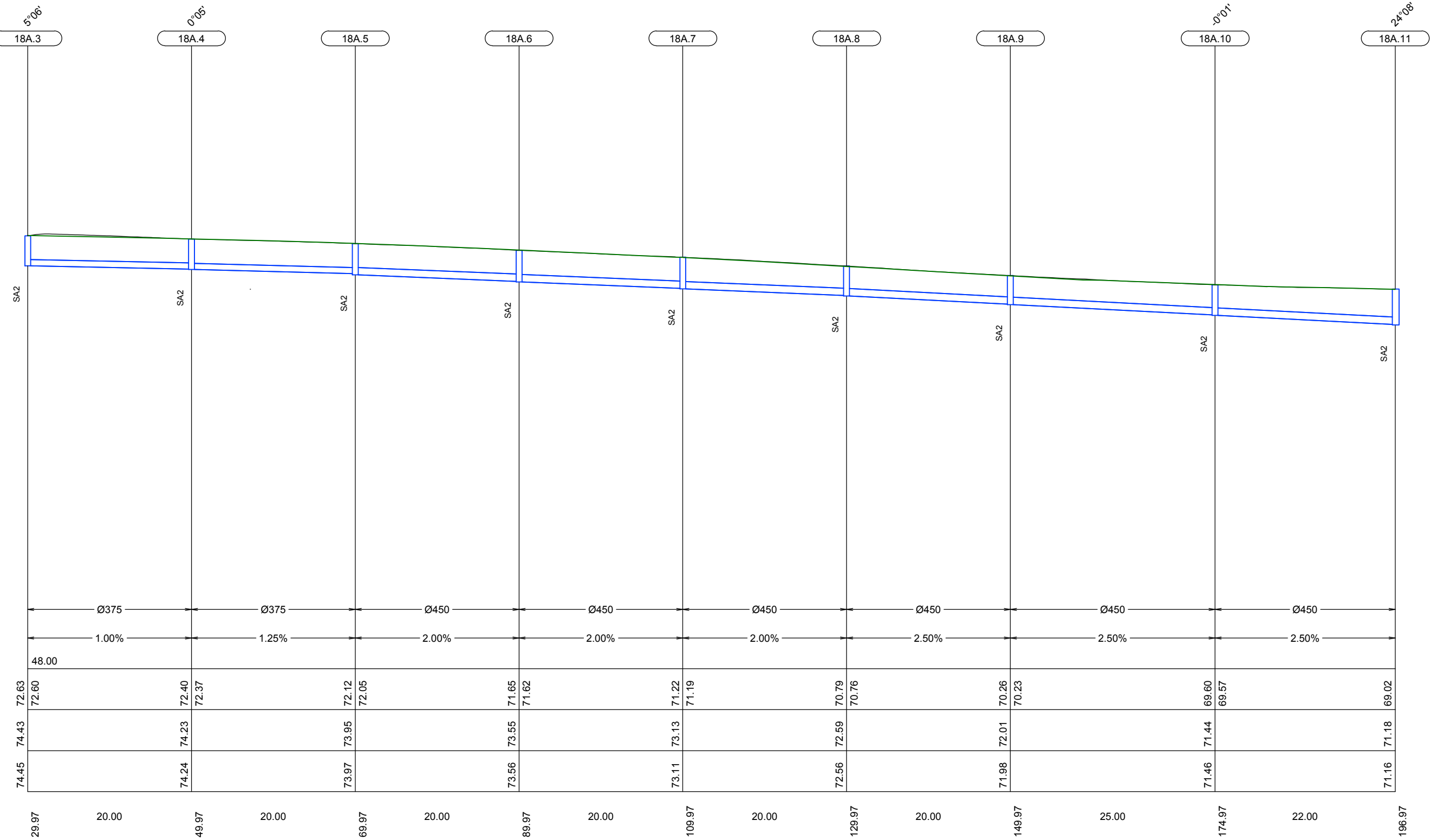
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Sheet No. 24

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 18a

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 25

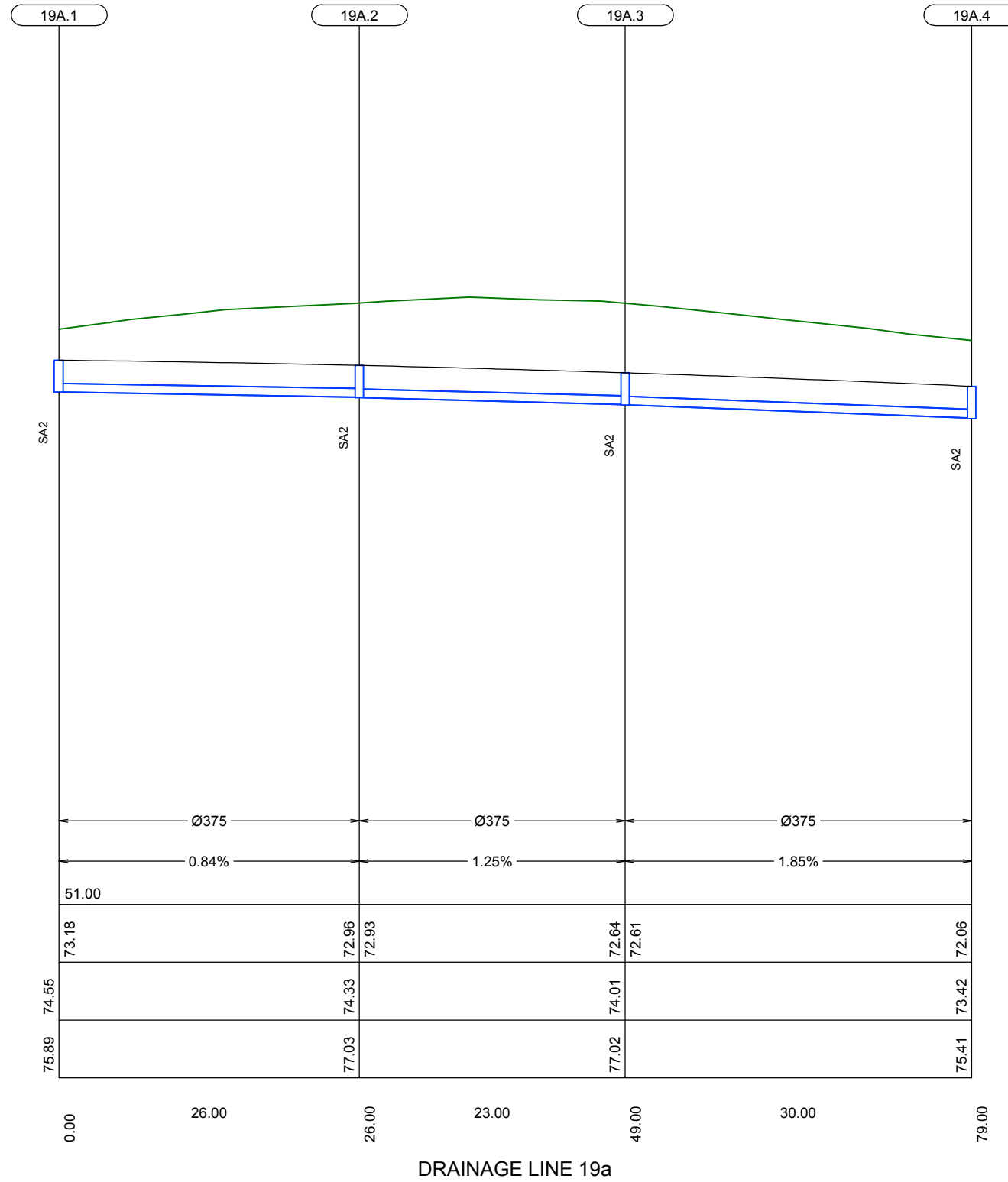
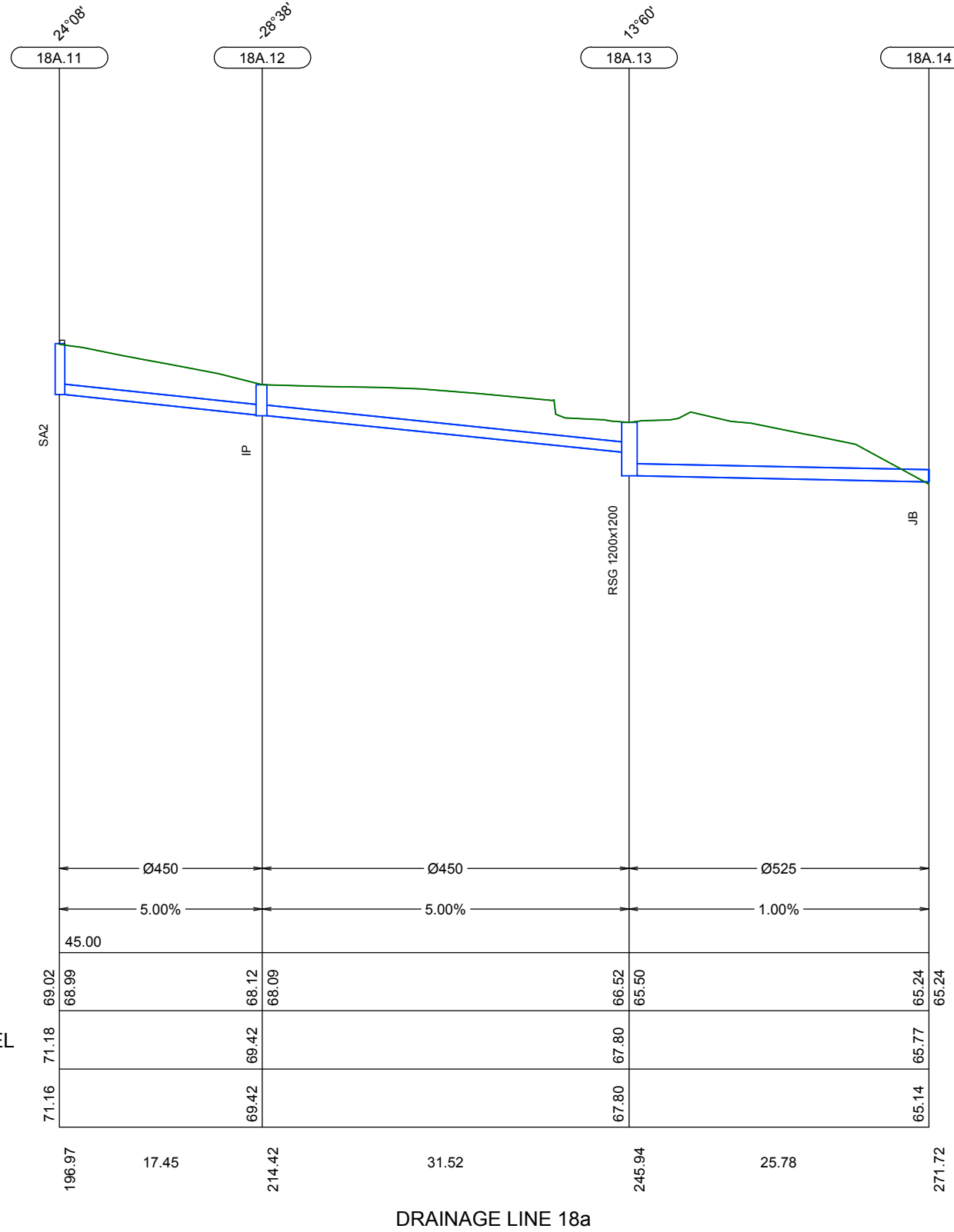


**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

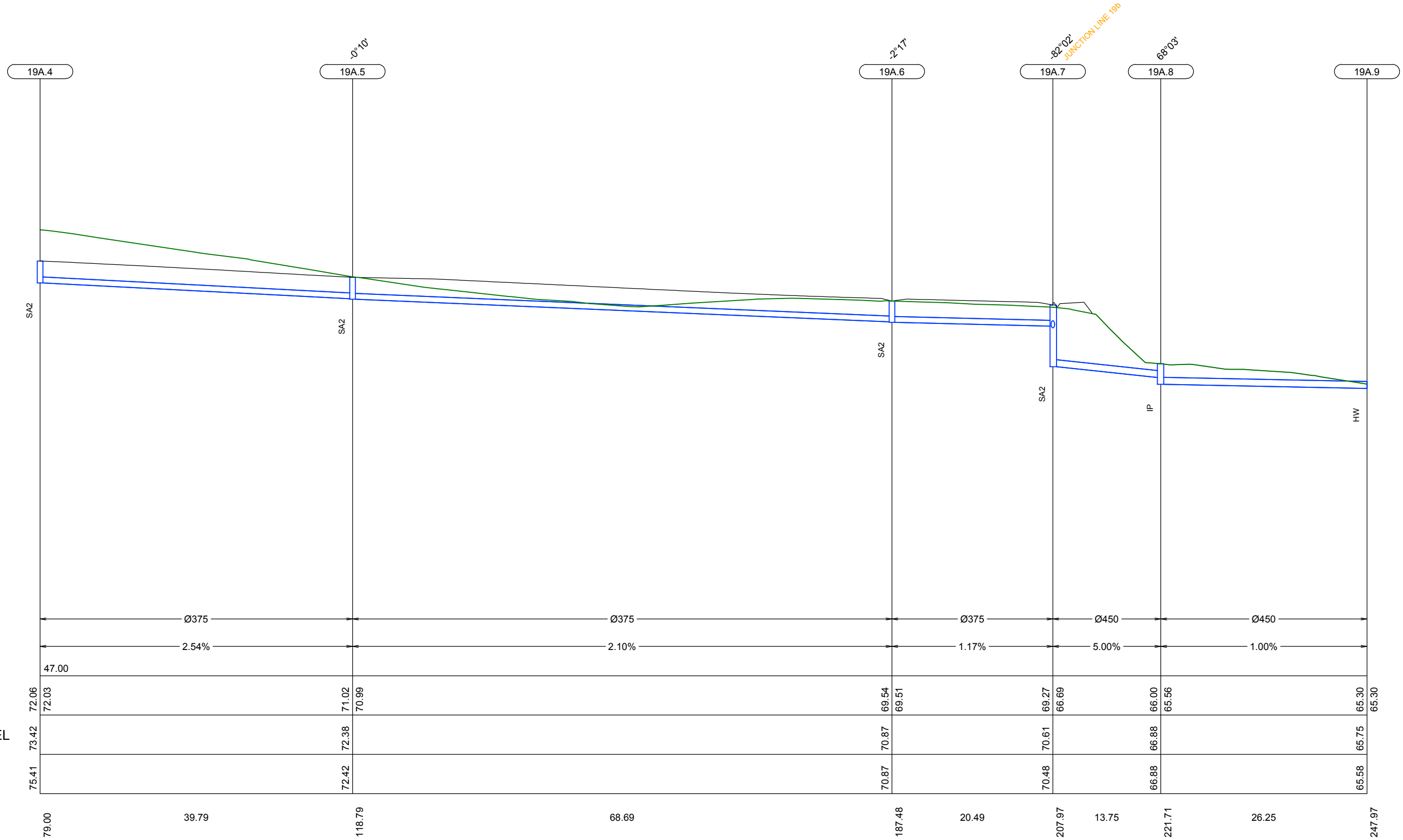
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Sheet No. 26

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 19a

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 27

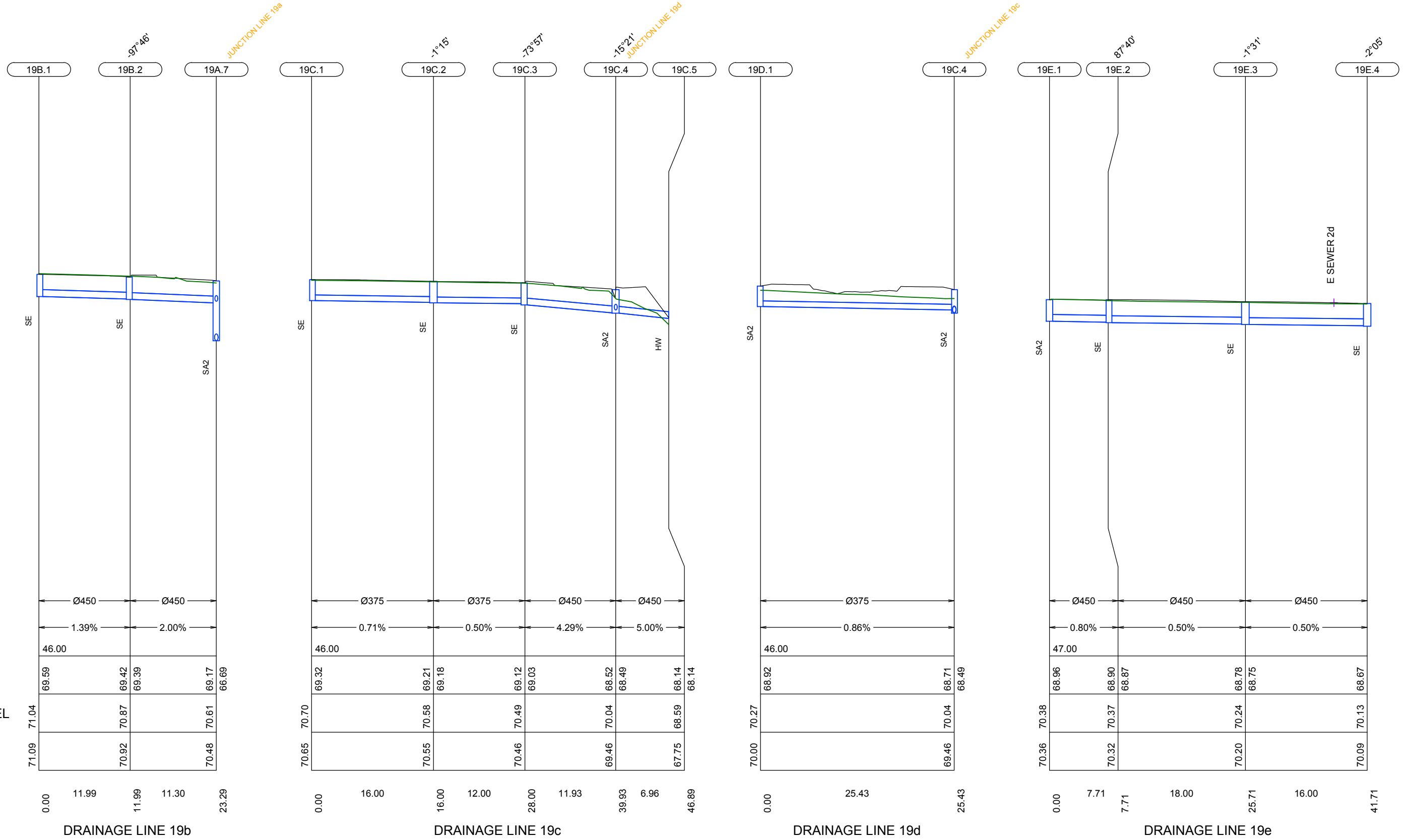


**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

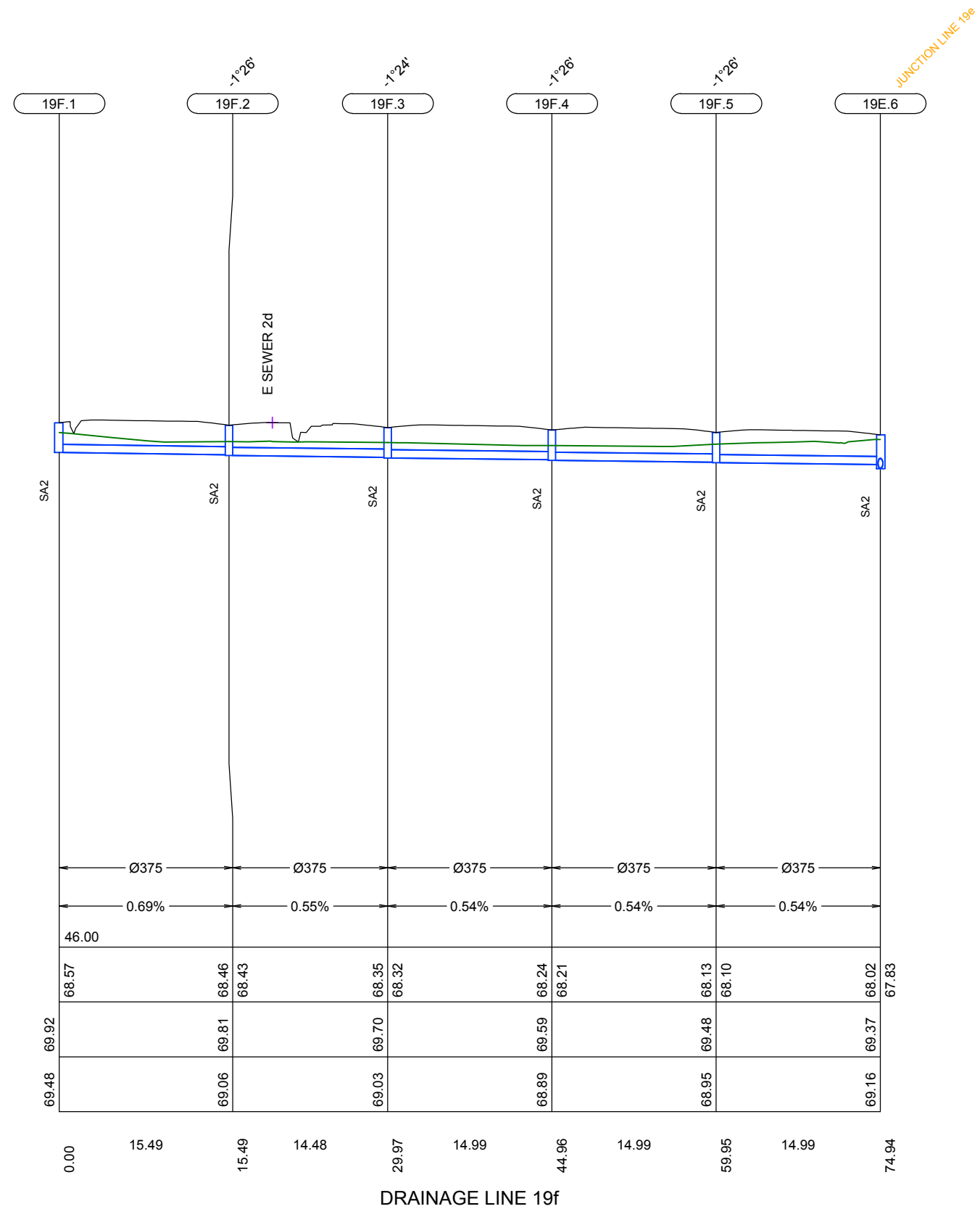
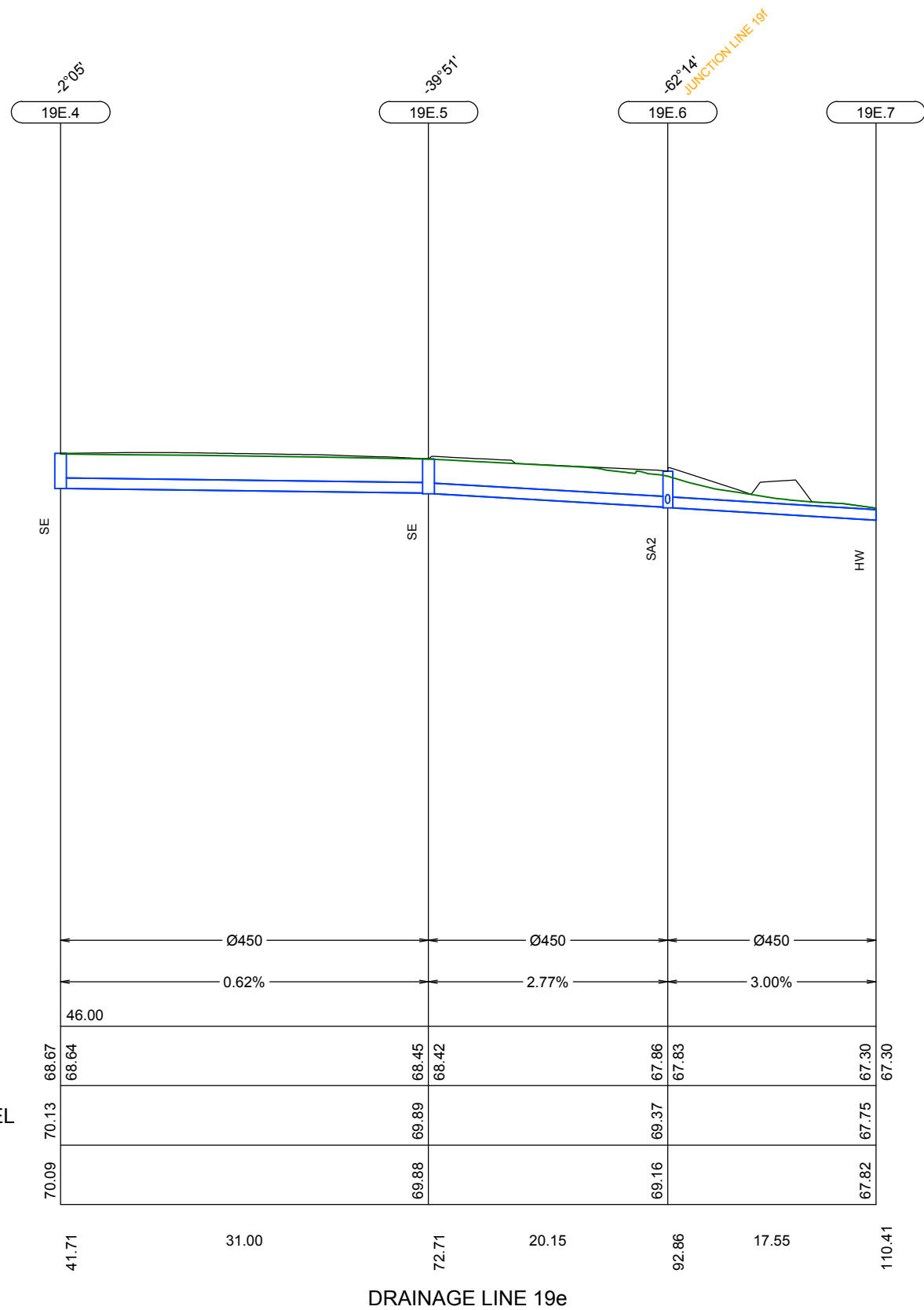
Vertical Scale 1:250  
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at A3  
Sheet No. 28

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

-  EXISTING SURFACE
-  DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

## CONCEPT DRAINAGE DESIGN LONGITUDINAL SECTIONS

Vertical Scale 1:250  
Horizontal Scale 1:500  
Sheet No. 29  
at A3

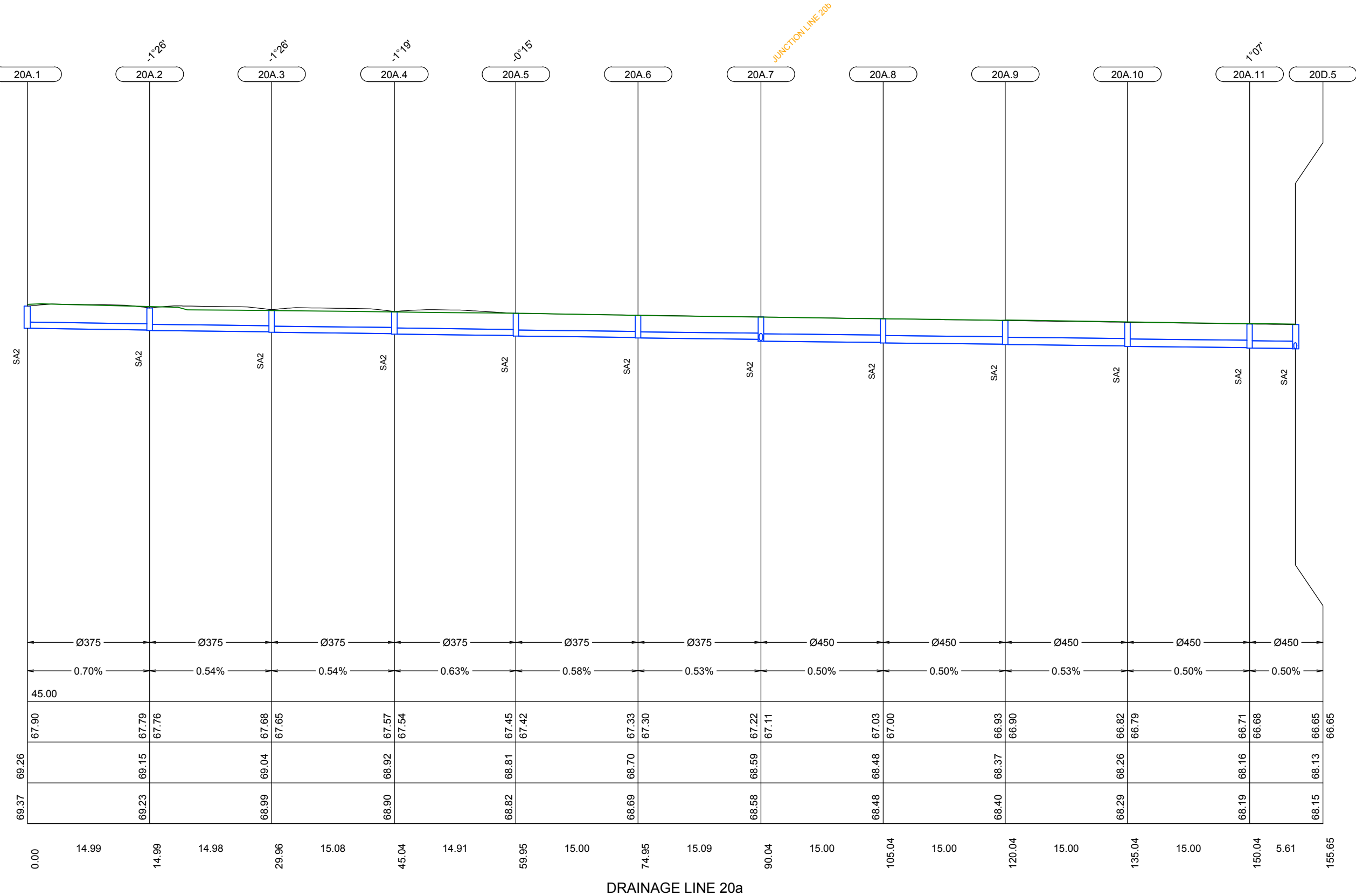


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 20a

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

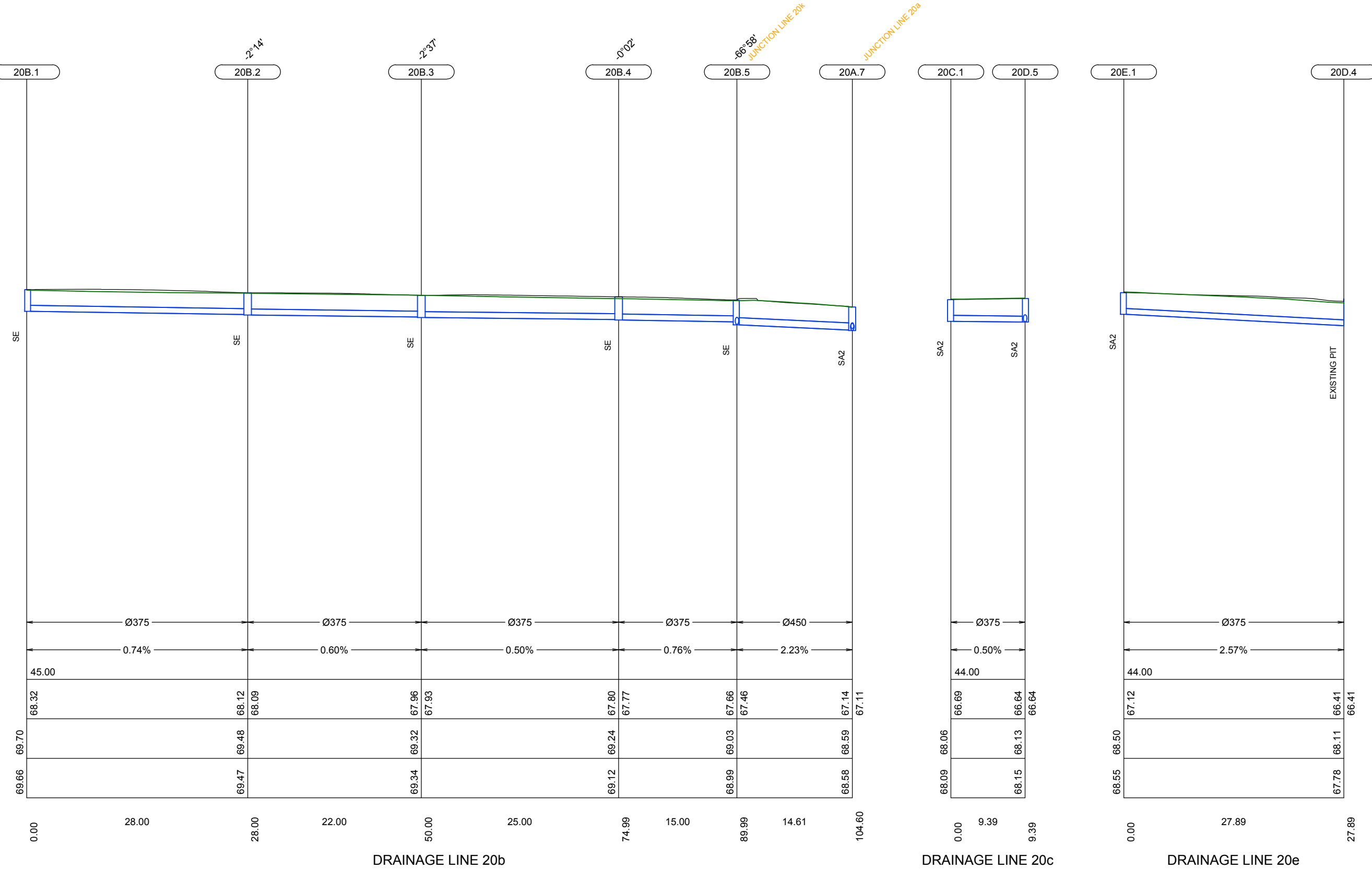
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Sheet No. 30  
at A3

**NOTES:**

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**LEGEND**

-  EXISTING SURFACE
-  DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 31

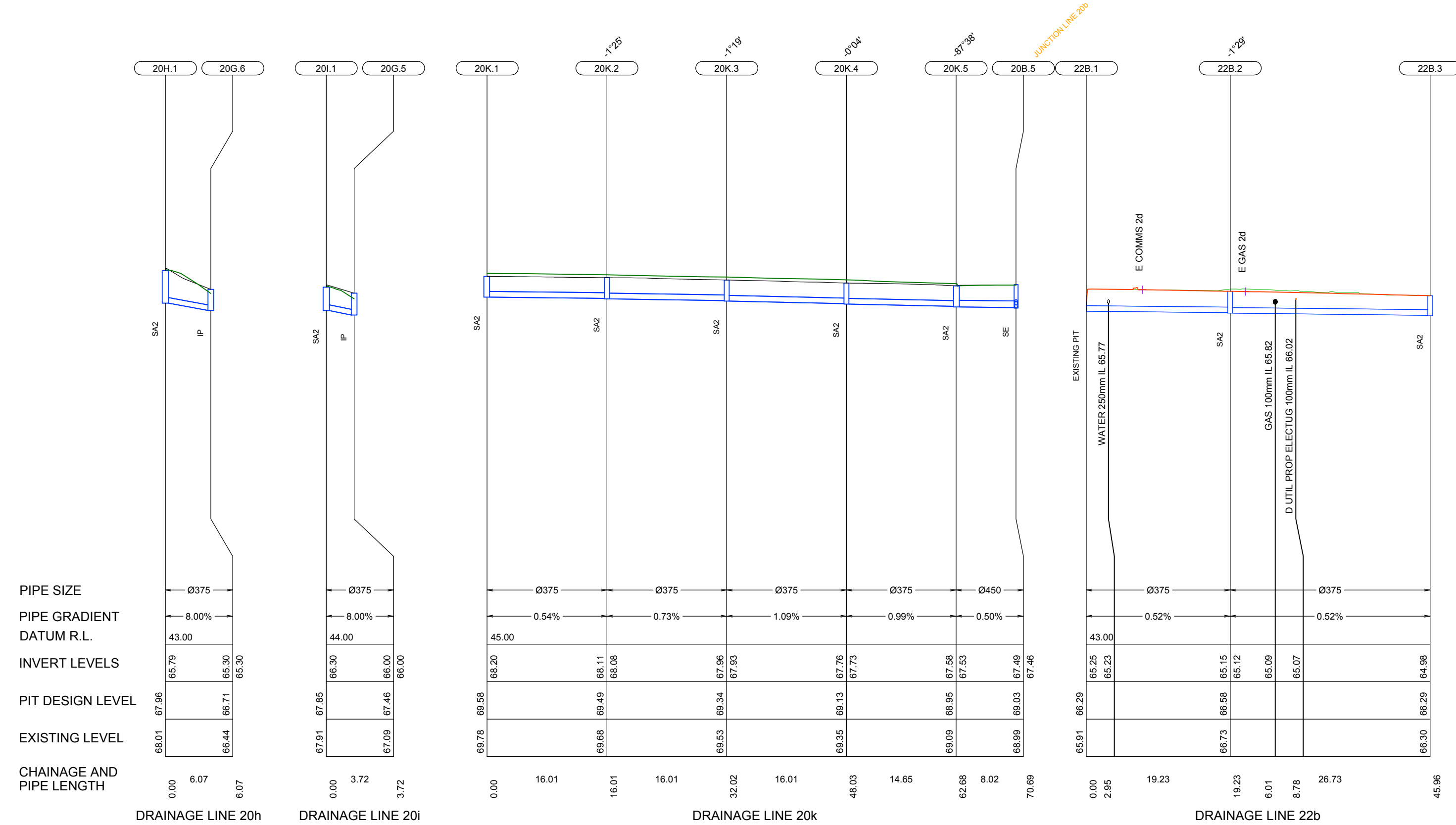


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
 NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
 DRAINAGE DESIGN  
 LONGITUDINAL SECTIONS**

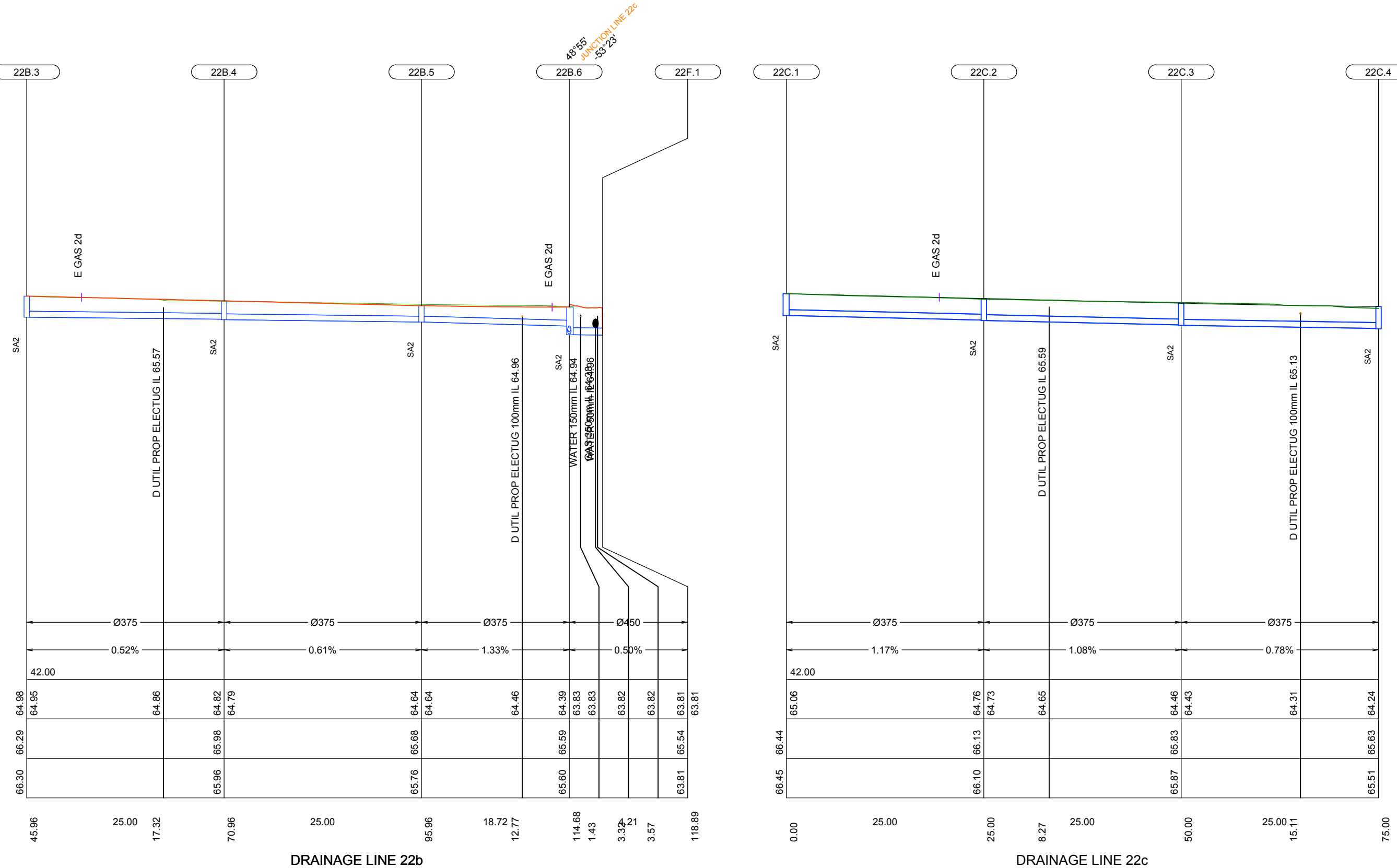
Vertical Scale 1:250  
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 Sheet No. 32

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 33

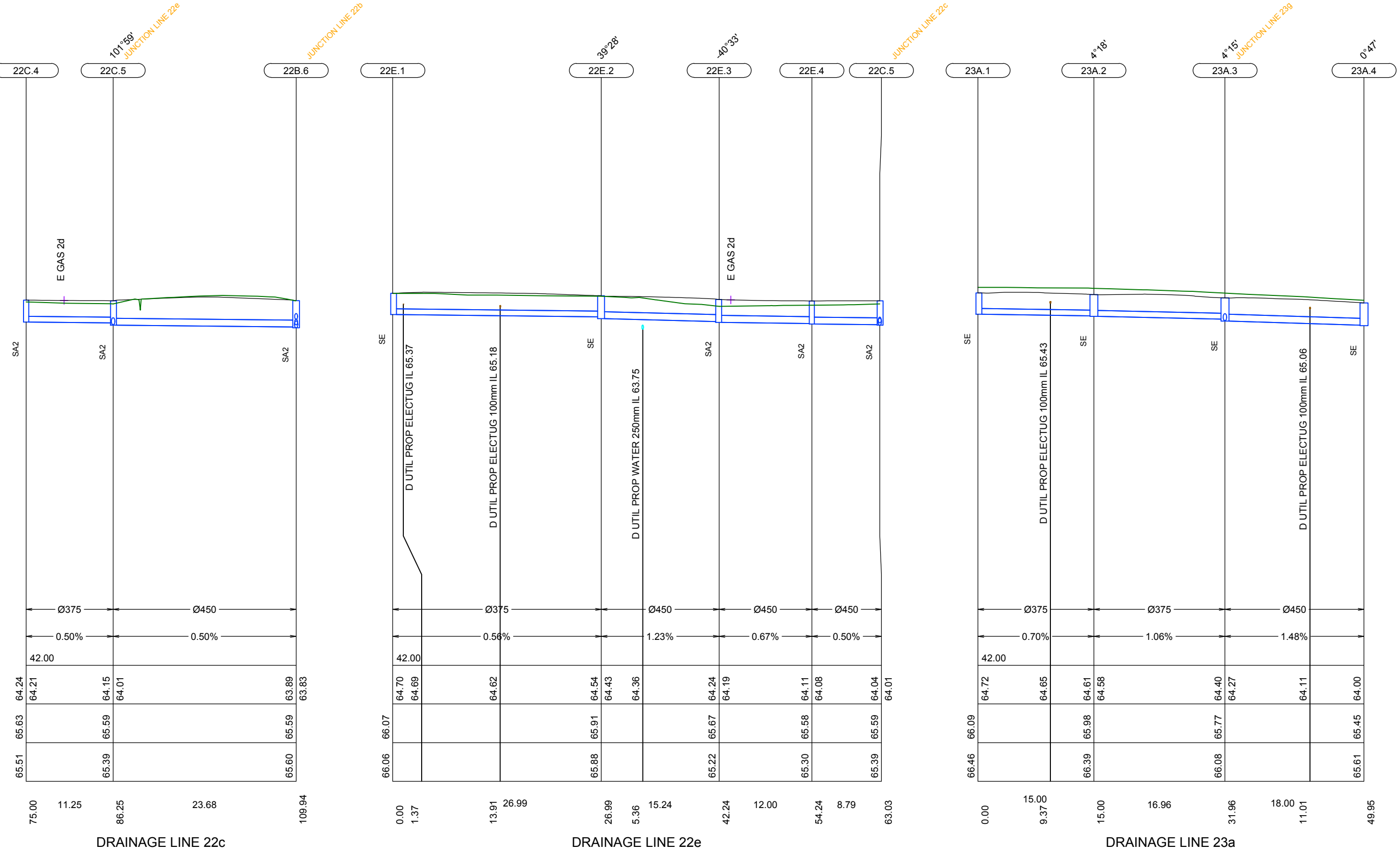


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

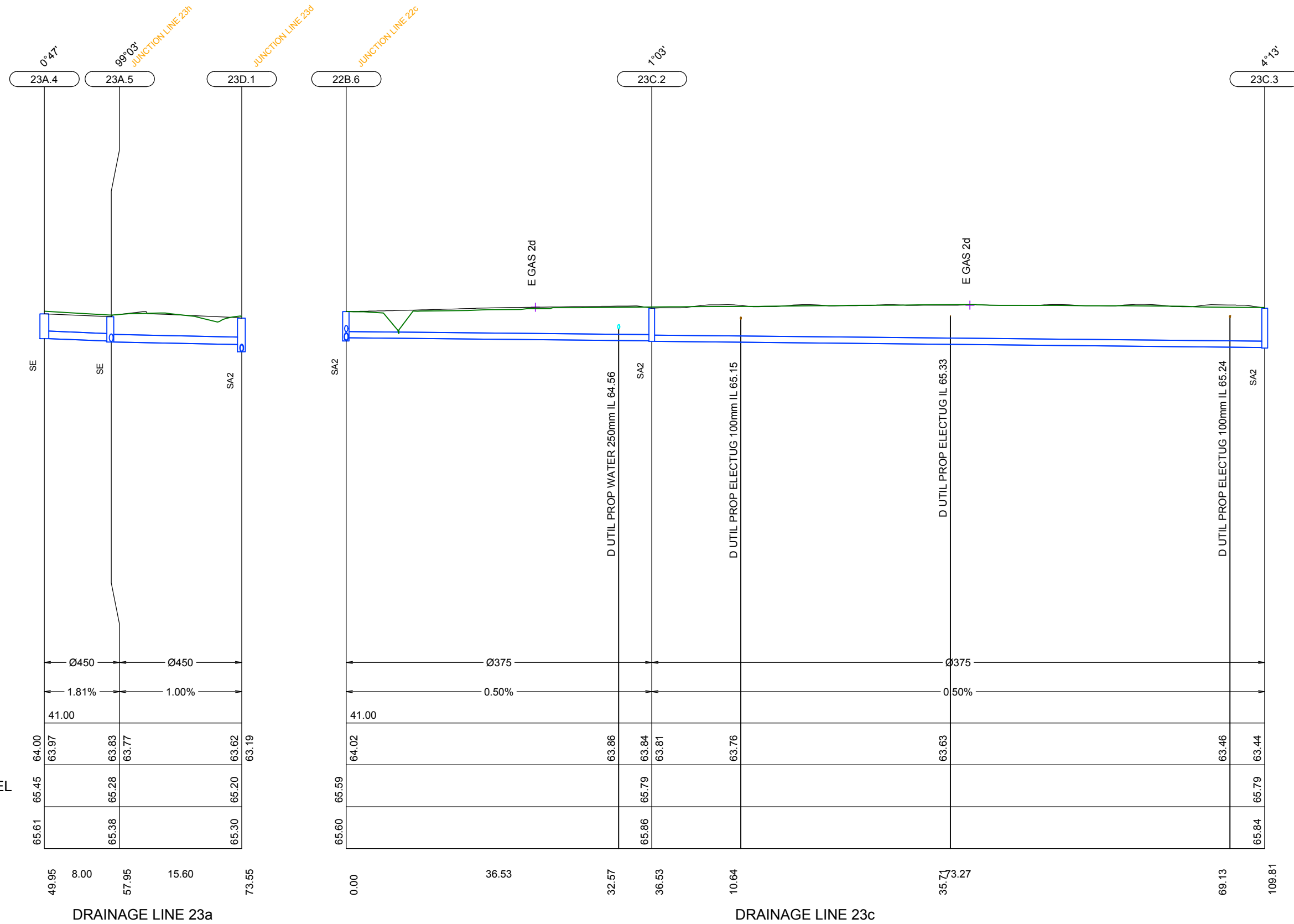
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Sheet No. 34

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

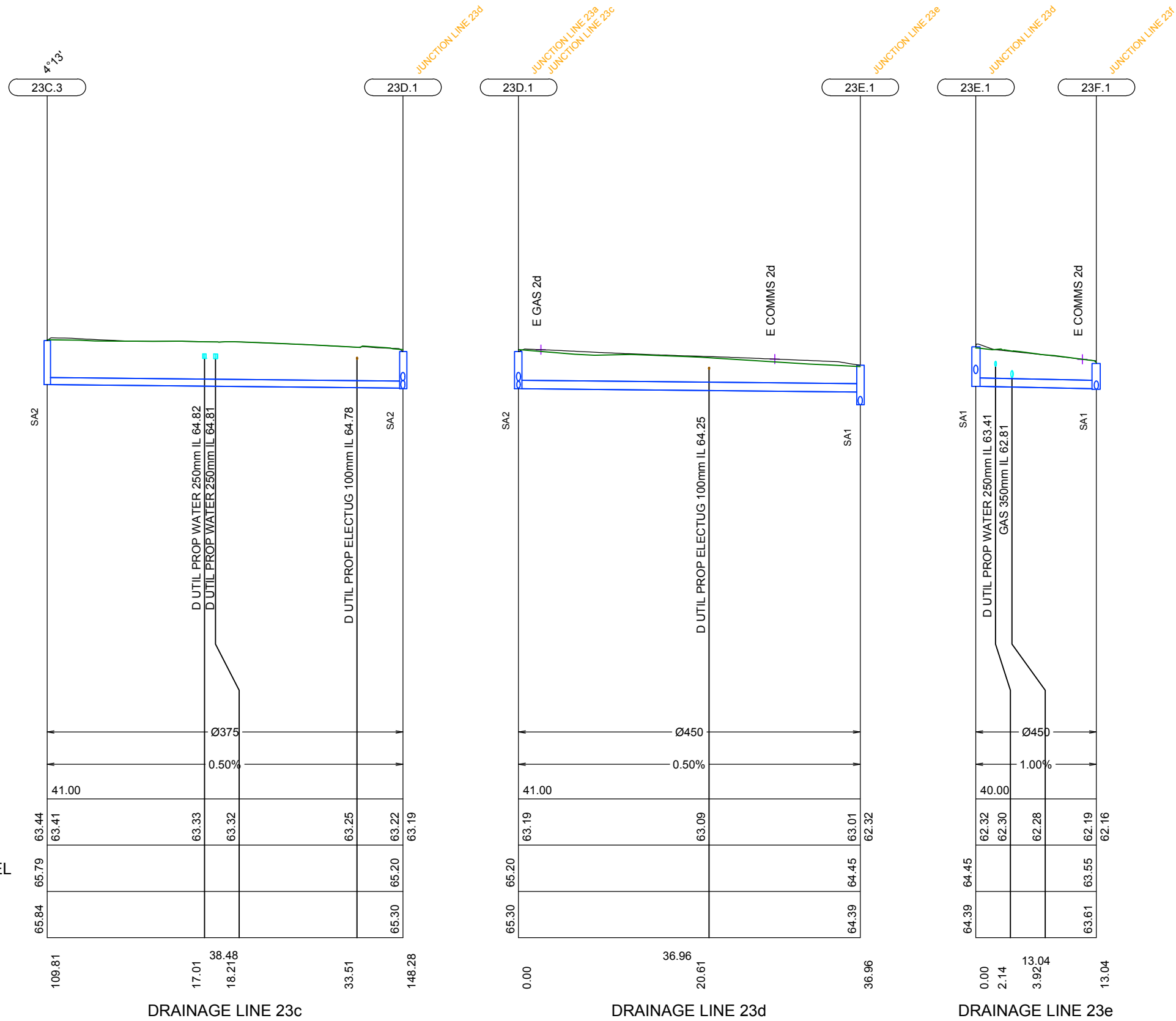
Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 35

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 36

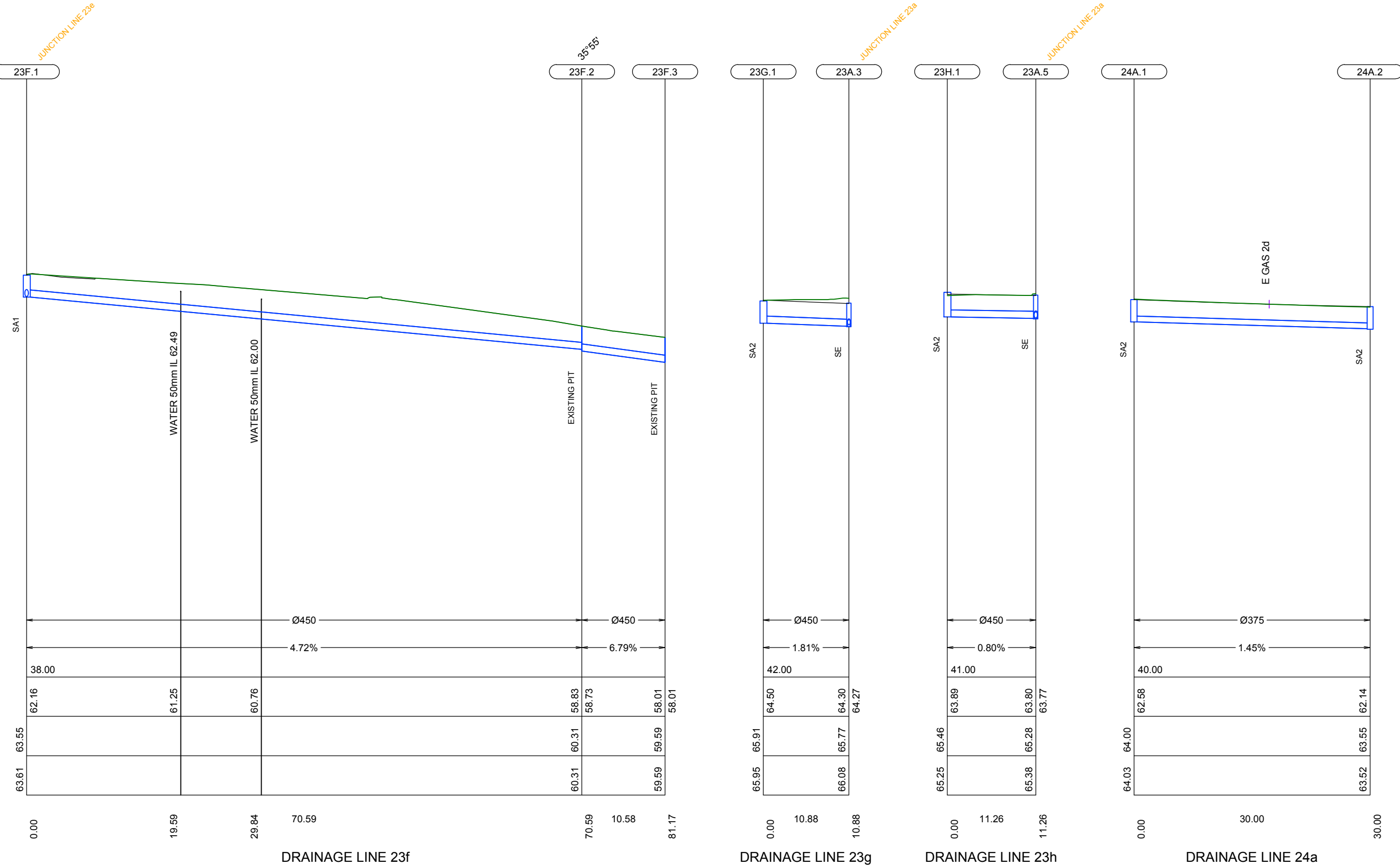


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION



**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

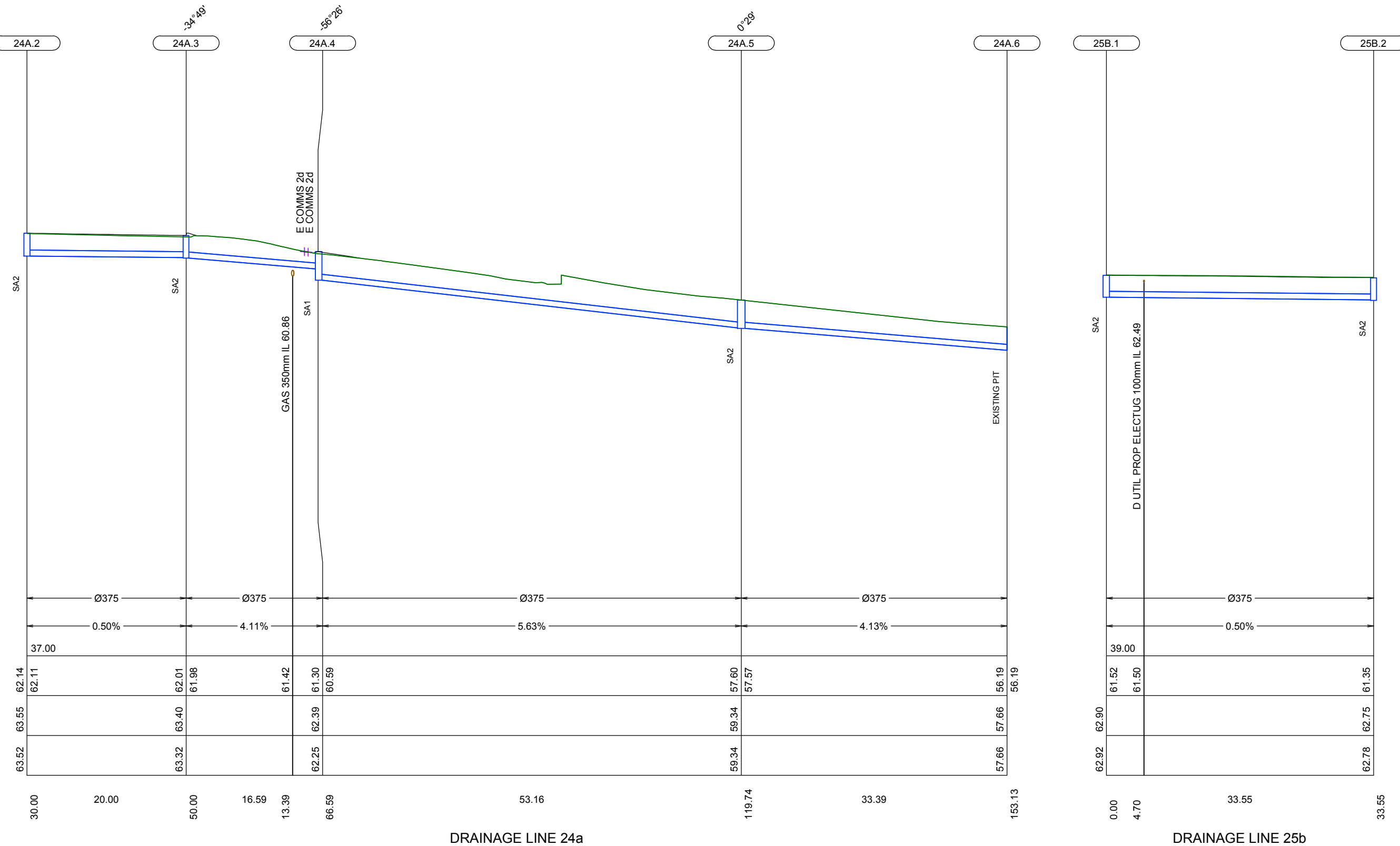
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Sheet No. 37

**NOTES:**

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**LEGEND**

-  EXISTING SURFACE
-  DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

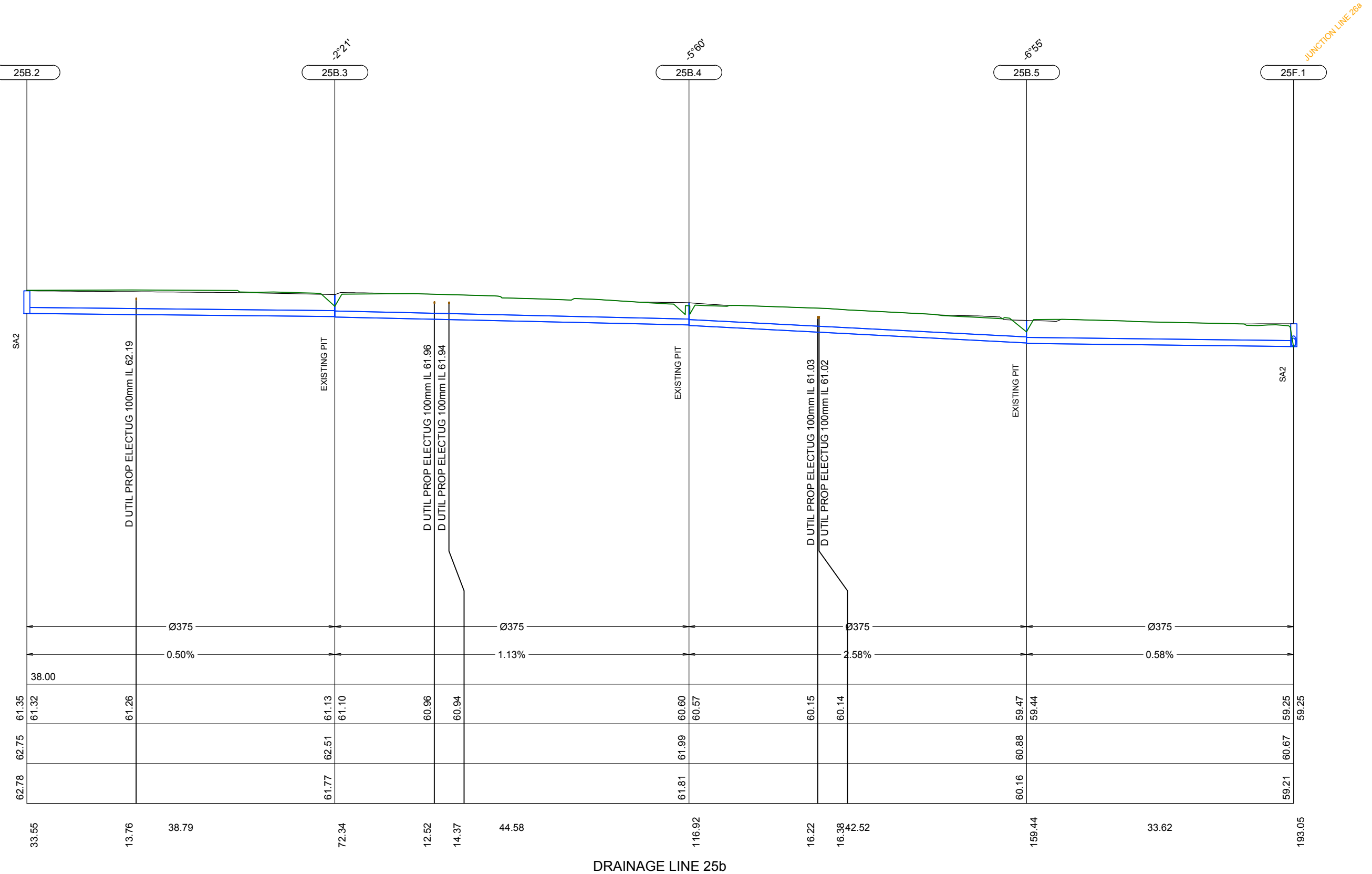
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Sheet No. 38

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 25b

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 39

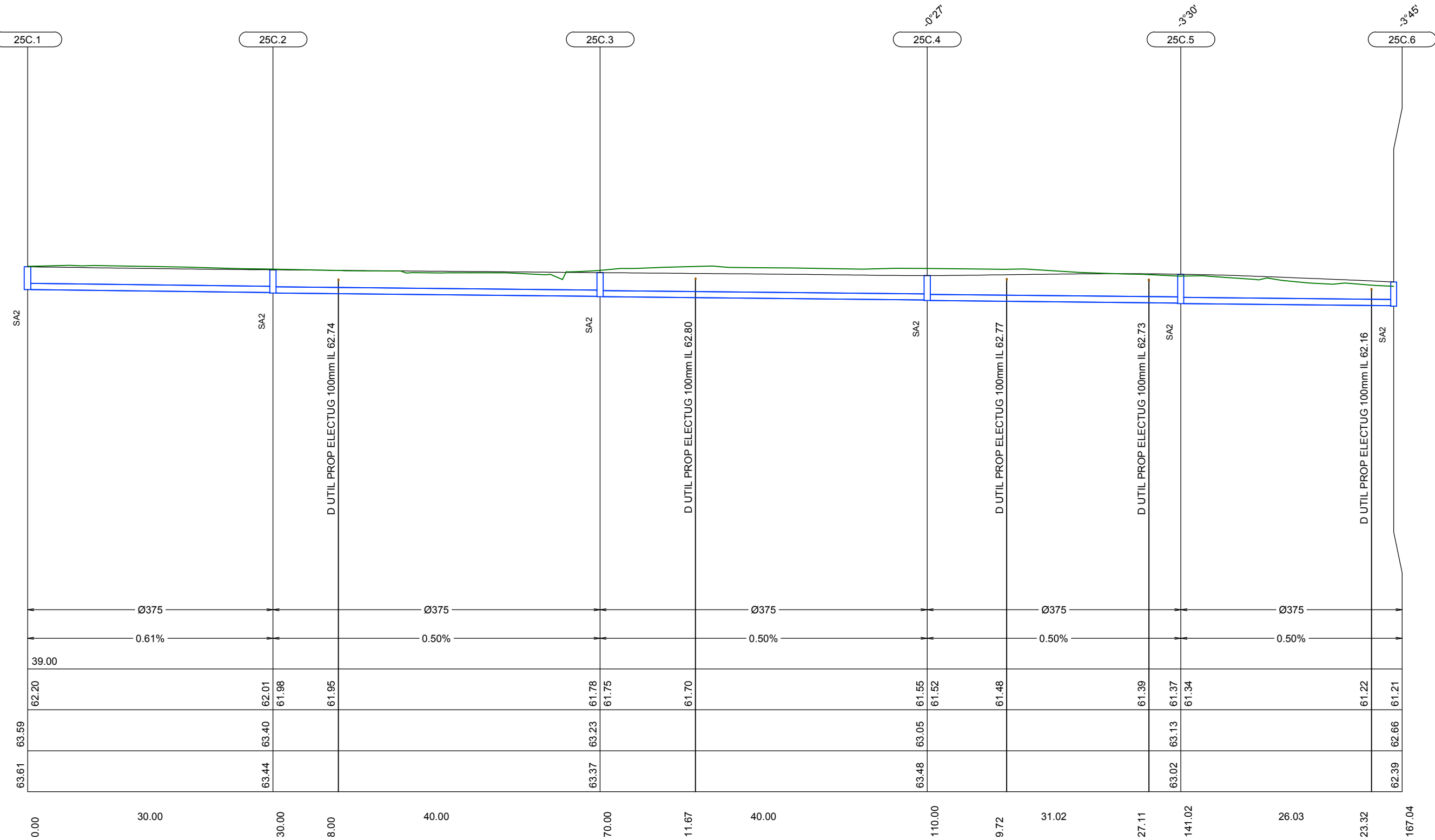


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



DRAINAGE LINE 25c

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

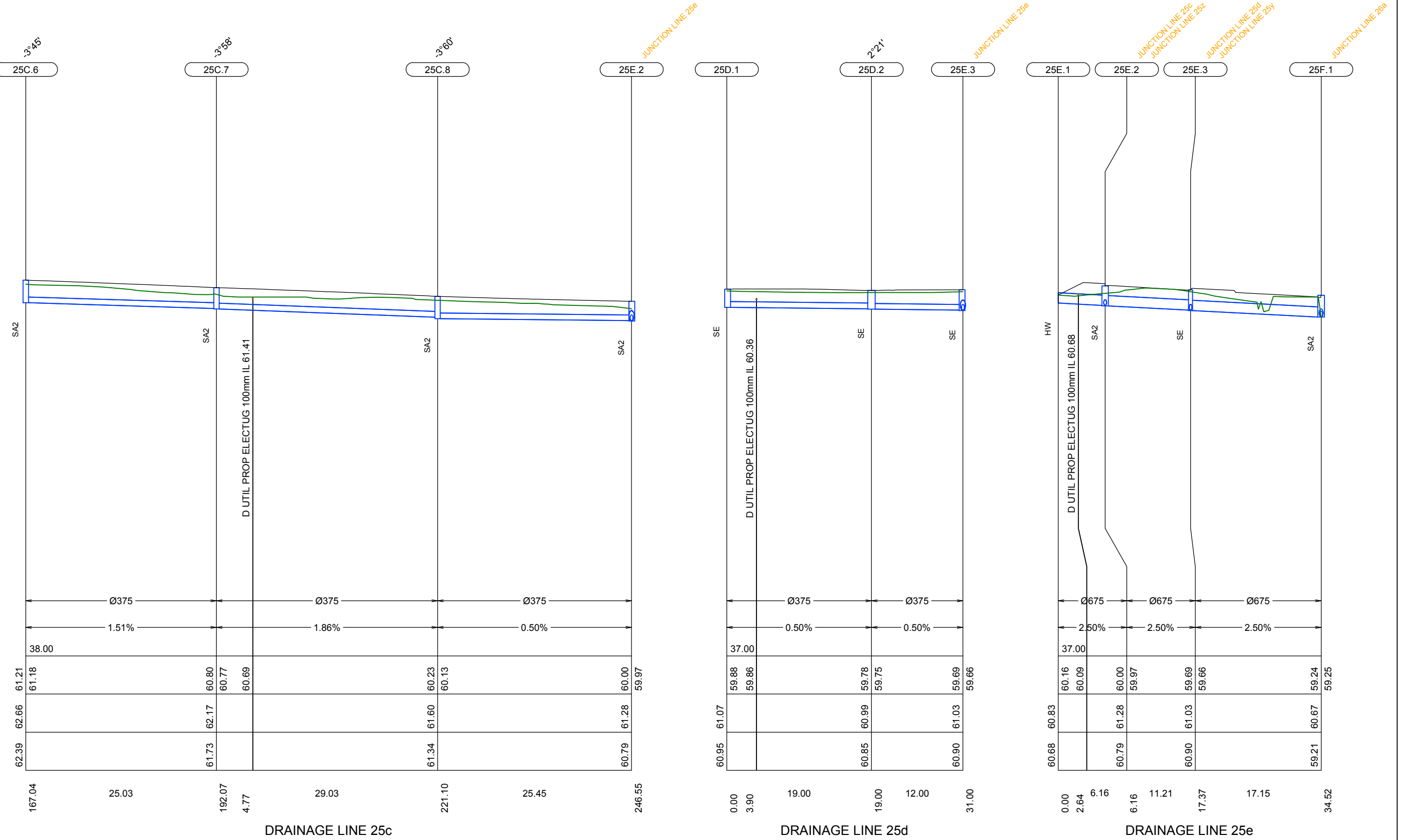
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Sheet No. 40

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

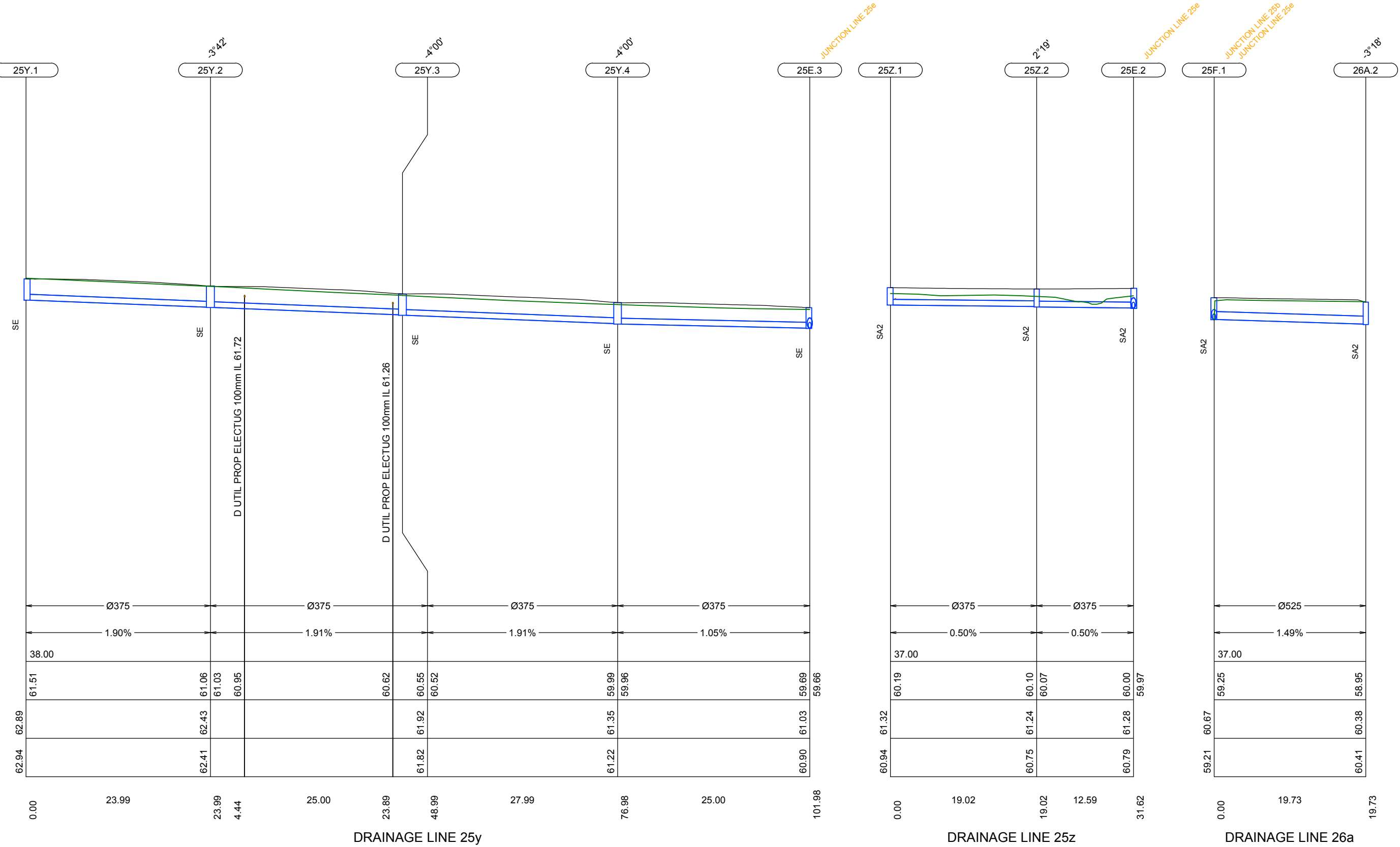
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Horizontal Scale 1:500  
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Sheet No. 41

**NOTES:**

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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
Sheet No. 42

at A3

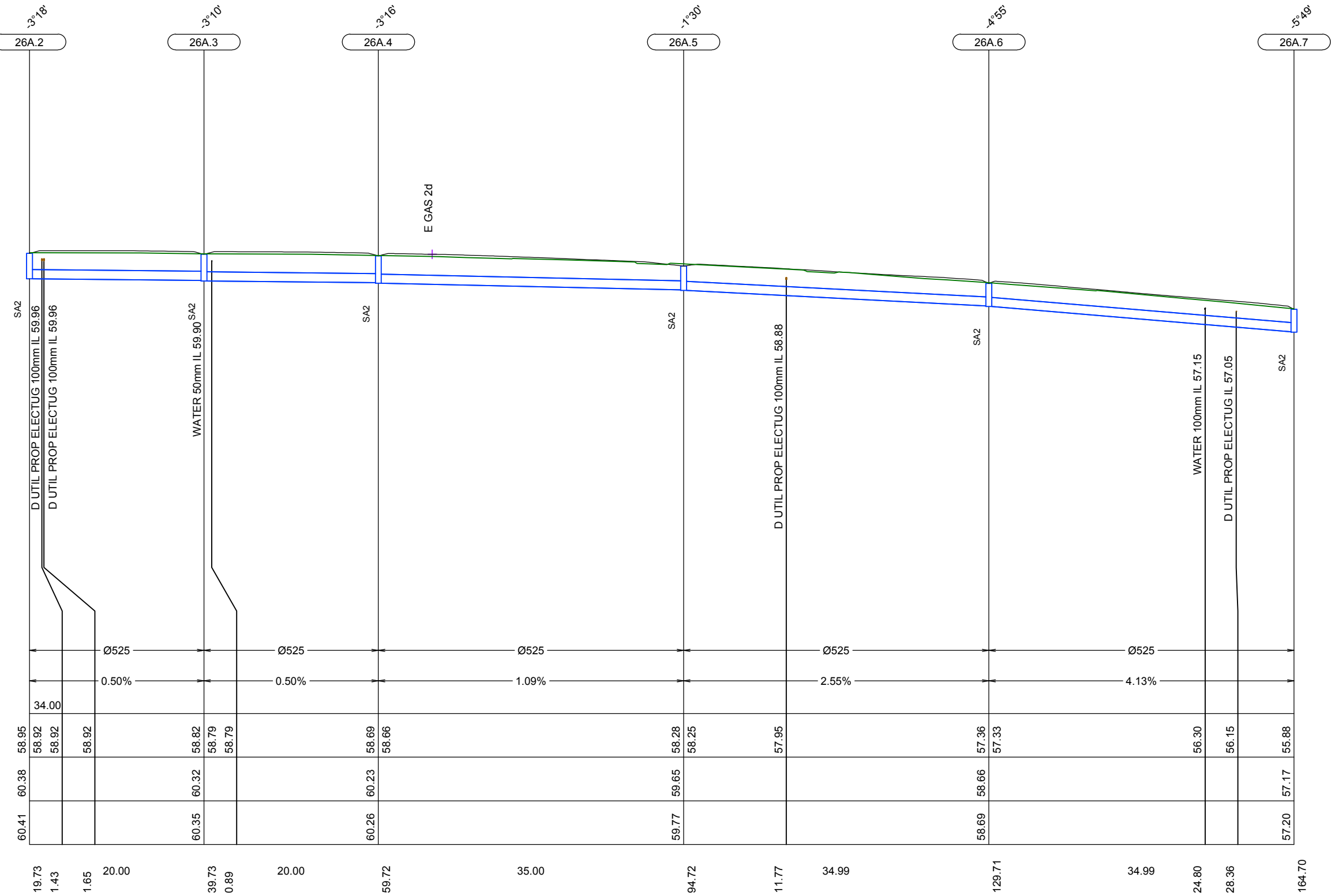


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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

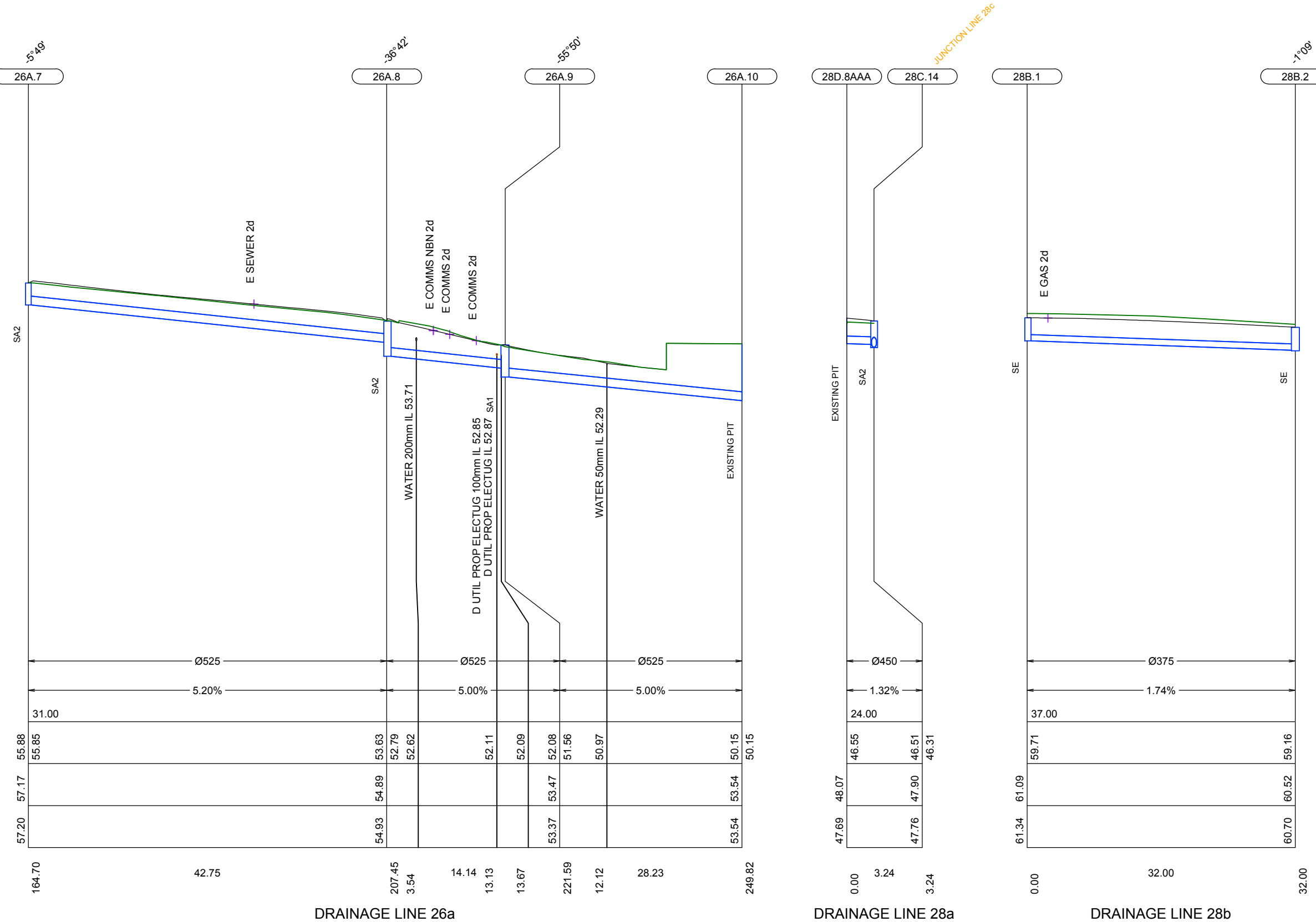
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at A3  
Sheet No. 43

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLES ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
Sheet No. 44

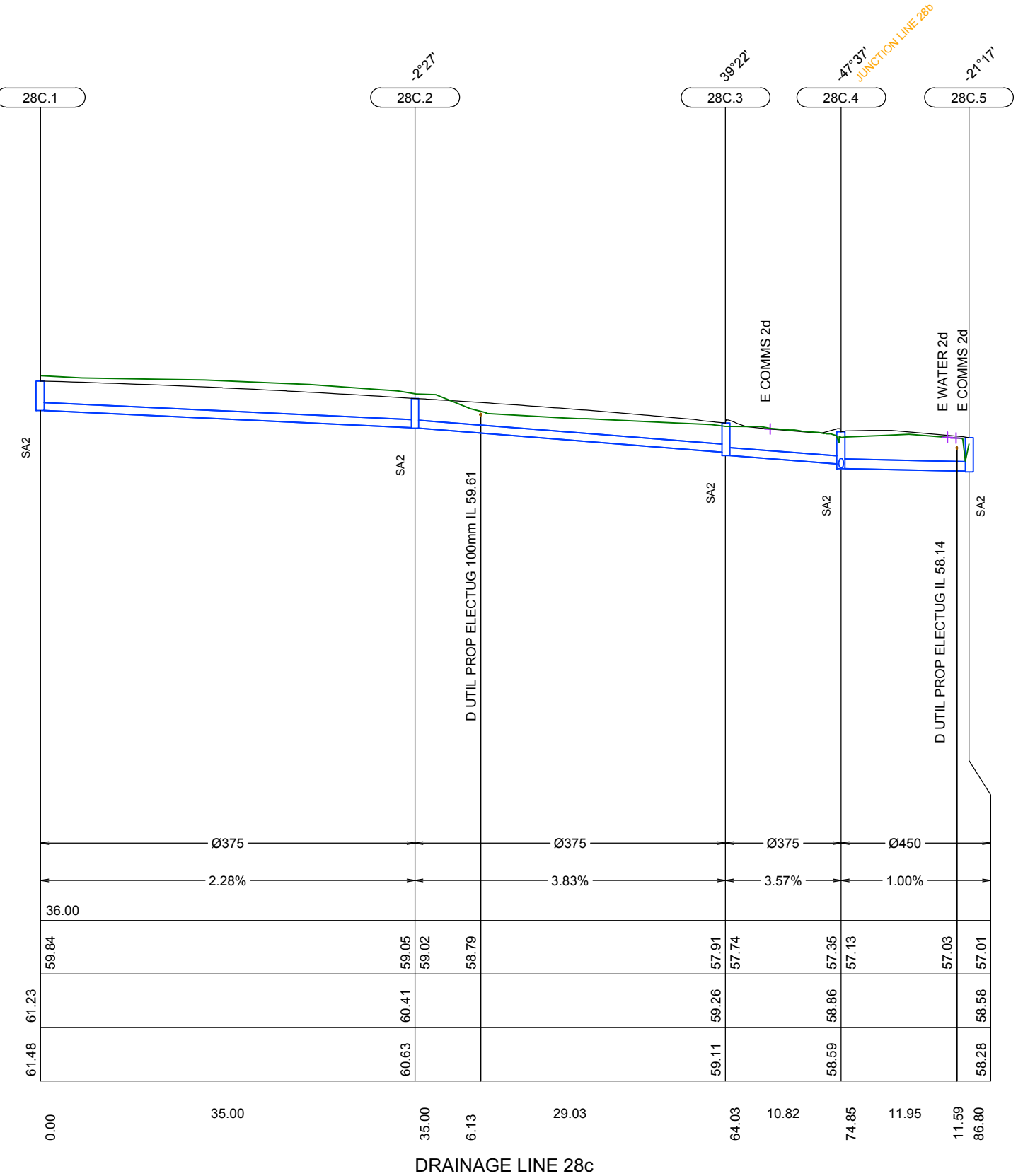
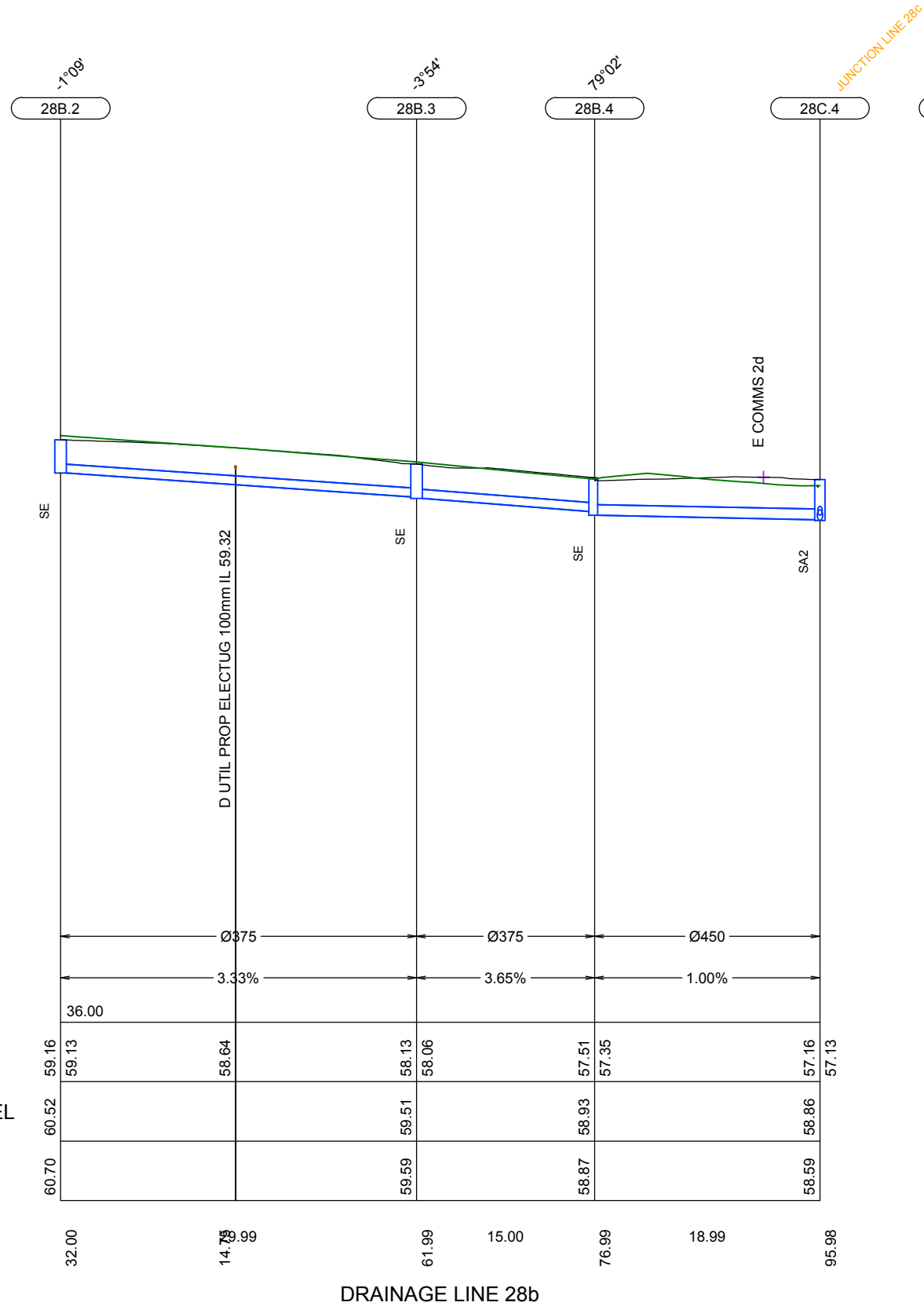
at A3

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 45

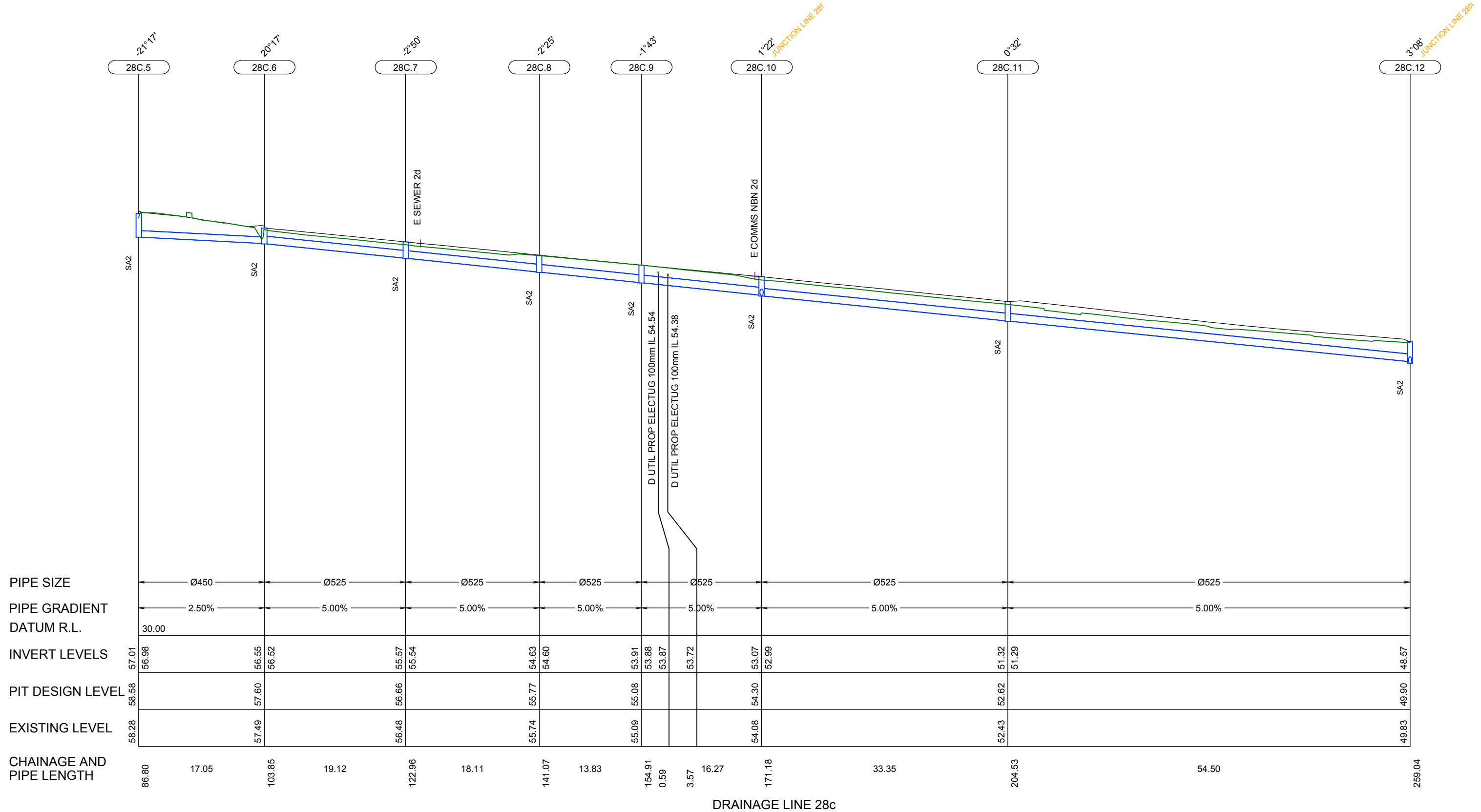


**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

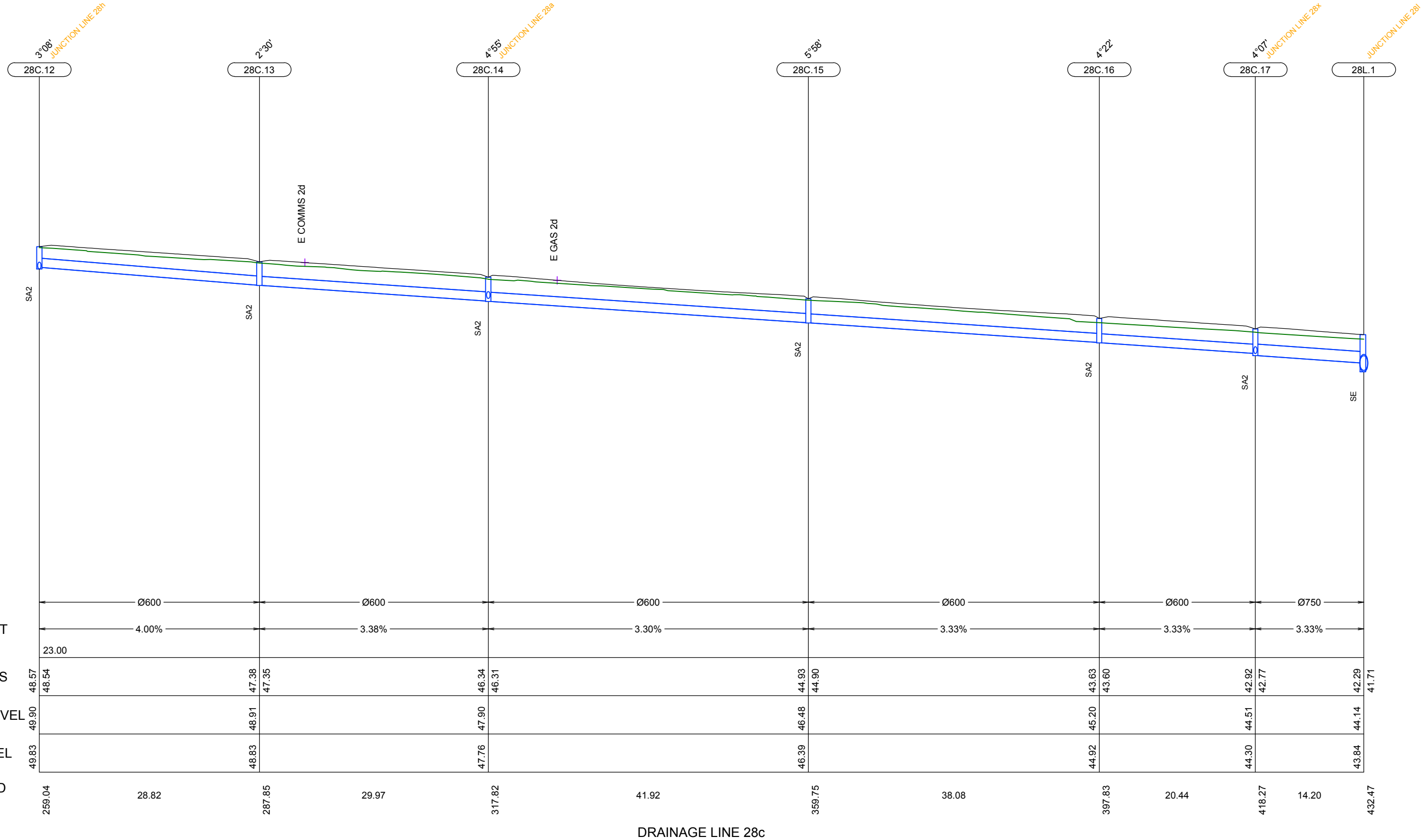
Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 46

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 47



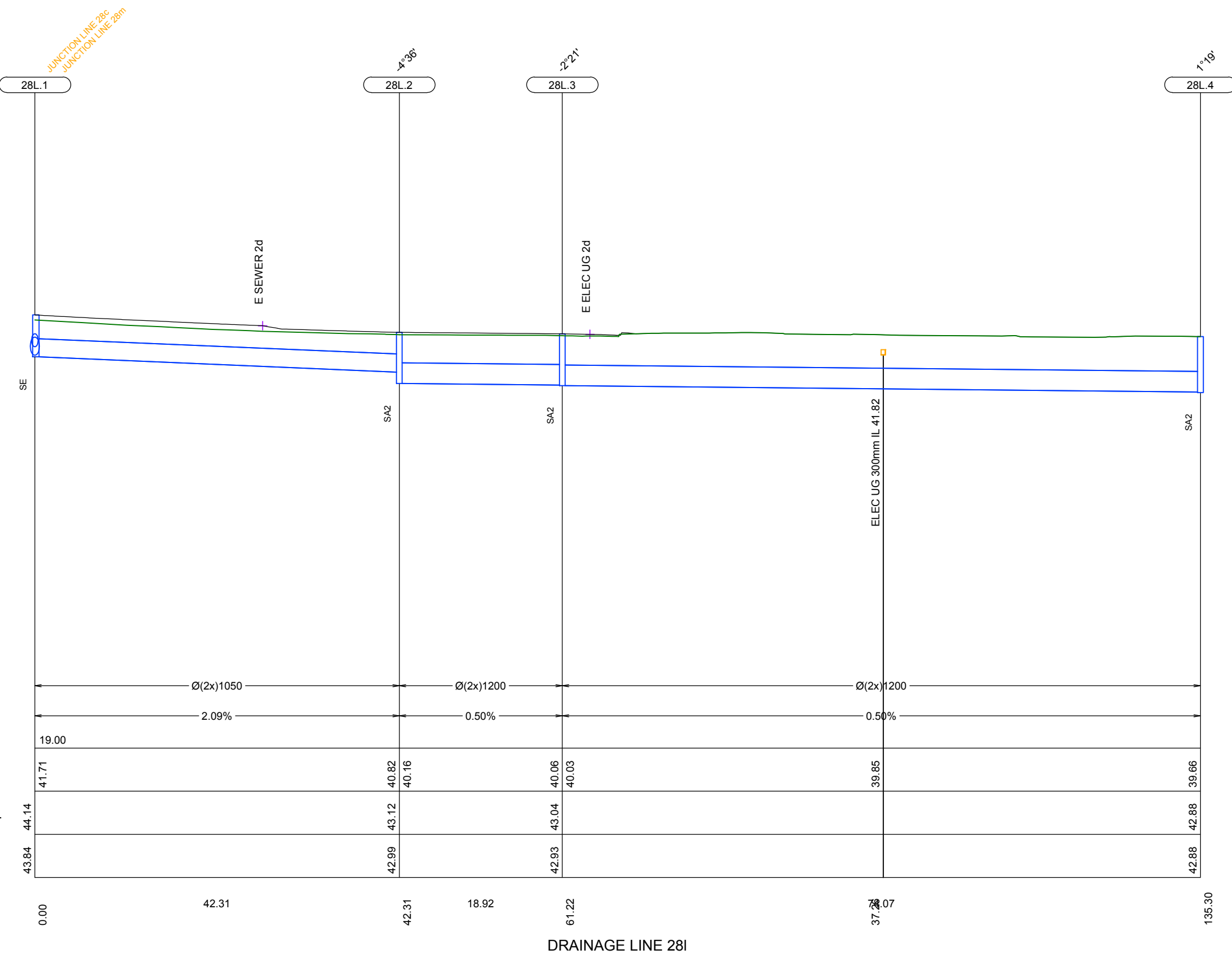


**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
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**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

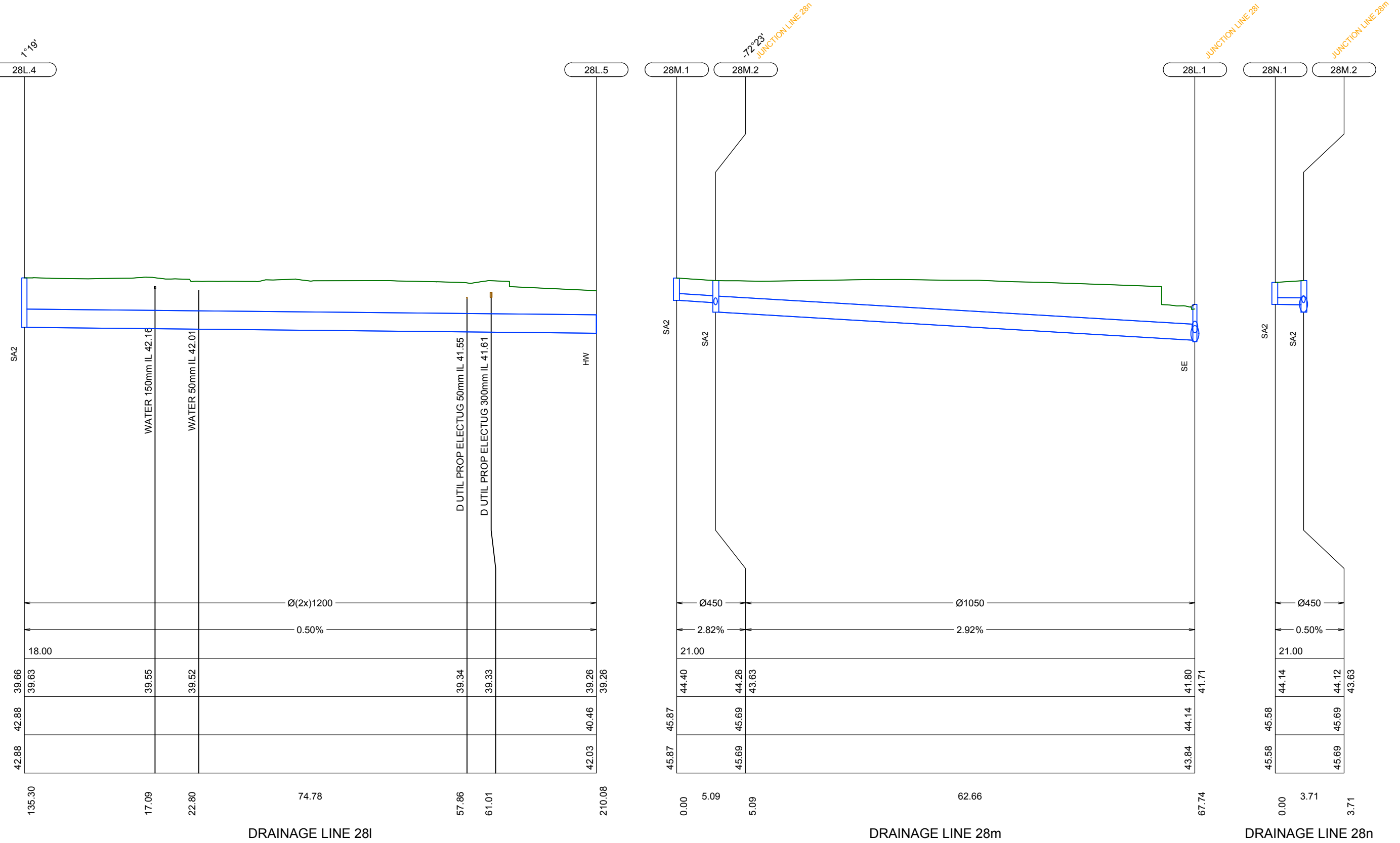
Vertical Scale 1:250  
Horizontal Scale 1:500  
at A3  
Sheet No. 49

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

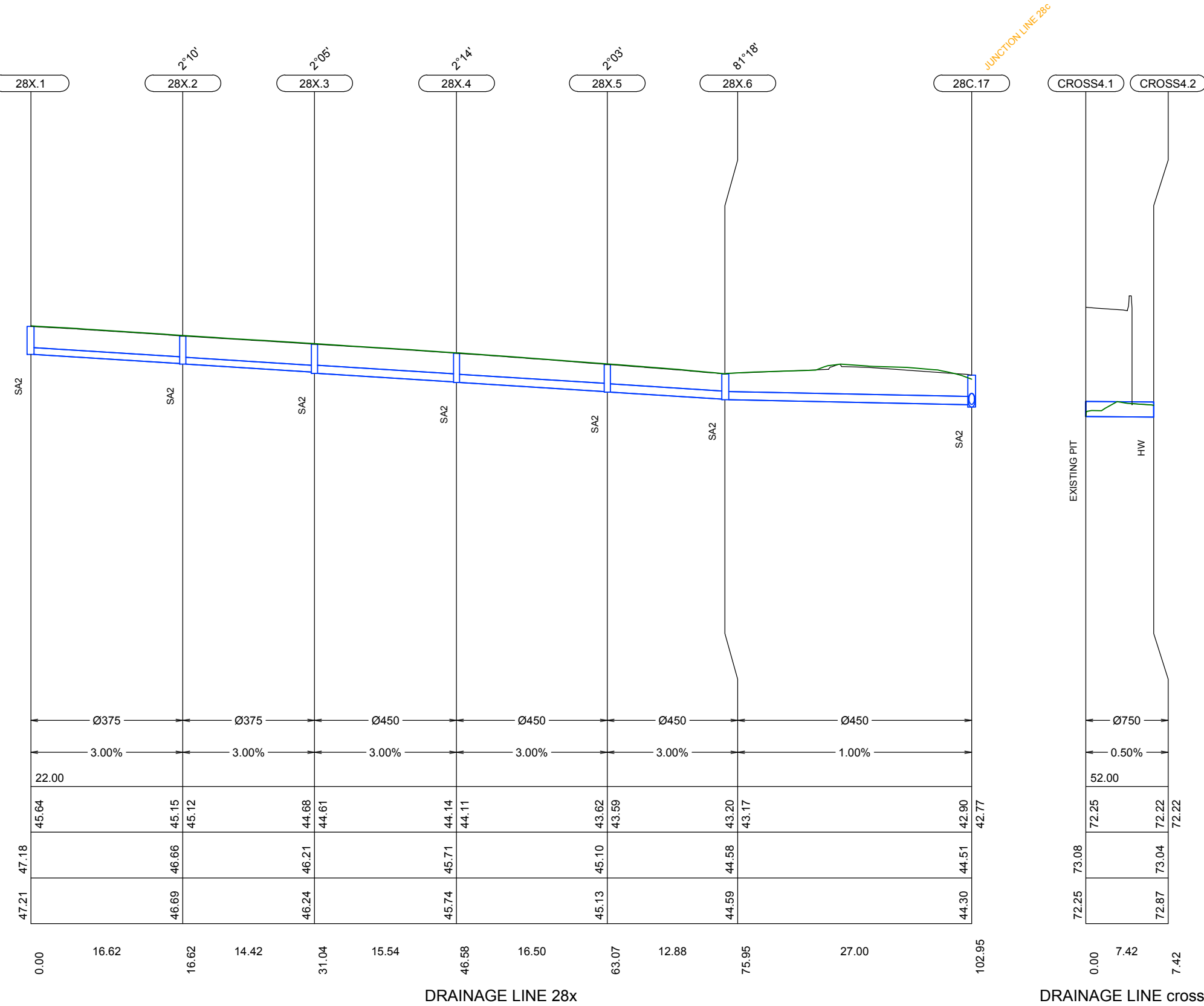
Sheet No. 50

**NOTES:**

1. LOCATIONS AND LEVELS OF ALL PROPOSED AND EXISTING UTILITIES CROSSING PROPOSED DRAINAGE LINES MUST BE CONFIRMED AT DETAILED DESIGN STAGE
2. ALL EXISTING "2D" UTILITIES LOCATIONS ARE INDICATIVE ONLY. POTHOLING ARE REQUIRED TO CONFIRM THE LOCATIONS AND LEVELS

**LEGEND**

- EXISTING SURFACE
- DESIGN LEVEL



**PRELIMINARY**  
NOT TO BE USED FOR CONSTRUCTION

**CONCEPT  
DRAINAGE DESIGN  
LONGITUDINAL SECTIONS**

Vertical Scale 1:250  
Horizontal Scale 1:500

at A3

Sheet No. 51



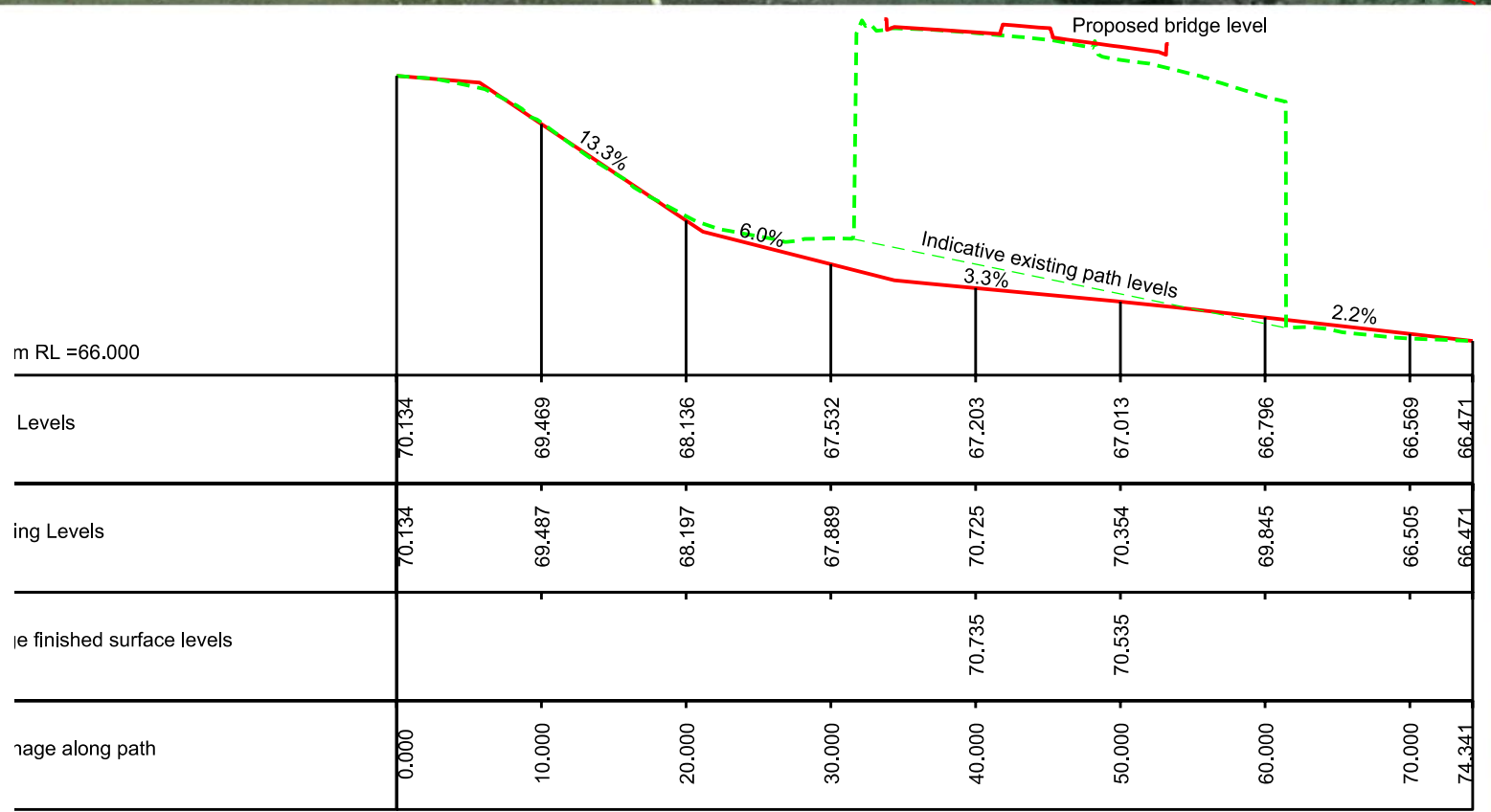
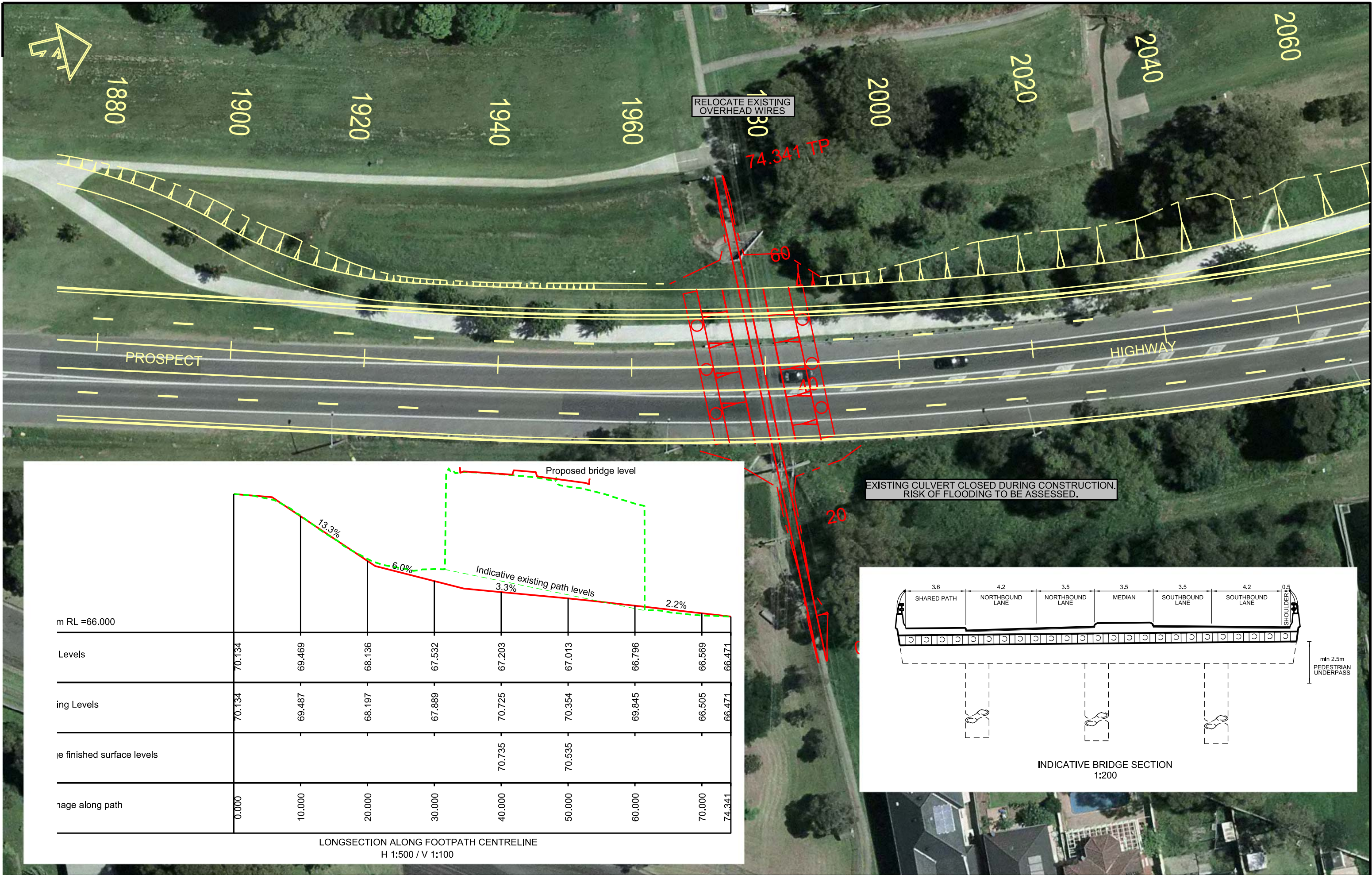
## APPENDIX C

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### SKETCH OF PROPOSED PEDESTRIAN UNDERPASS (MC10 CH 1980) – SK90







LONGSECTION ALONG FOOTPATH CENTRELINE  
H 1:500 / V 1:100

