

CURTIN UNIVERSITY

**PROJECT DELIVERY GUIDELINE
REFERENCE DOCUMENT (PUBLIC REALM)**

**STANDARD IRRIGATION
SPECIFICATIONS 000491**



Curtin University

Details of revisions

<i>Level</i>	<i>Details</i>	<i>Date</i>	<i>Initial</i>
<i>01</i>	<i>Standard Irrigation Specification</i>	<i>03/12/19</i>	

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1 GENERAL

Curtin University (CU) is committed to the sustainable use of water resources and maximising the efficiency of its landscape irrigation systems

The purpose of this standard specification is to outline the requirements and expectations of CU in relation to the provision of irrigation infrastructure assets and to provide a concise point of reference in the assessment of submissions for approval related to the development of amenities, public open spaces and streetscapes located on CU property.

All work carried out will be as detailed and in accordance with this Specification and associated drawings, the whole of which shall be deemed to constitute one document. Any application to deviate from the documented specification and drawings should be submitted for approval to the University of CU's Irrigation Technical Officer in writing.

This specification shall be read in conjunction of CU standard installation/construction drawings including:

DRAWING	DESCRIPTION	REV
01SITE-IRDT0001-02	TYPICAL BORE DISCHARGE ASSEMBLY	02
01SITE-IRDT0002-02	TYPICAL ELECTRICAL CUBICLE	02
01SITE-IRDT0003-02	AUTOMATIC IRRIGATION - TRENCHING	02
01SITE-IRDT0004-02	AUTOMATIC IRRIGATION – ISO VALVES	02
01SITE-IRDT0005-02	AUTOMATIC IRRIGATION – SOL VALVES & SPR	02
01SITE-IRDT0006-02	AUTOMATIC IRRIGATION – TWS TYPE 1	02
01SITE-IRDT0007-02	AUTOMATIC IRRIGATION – TWS TYPE 2	02

Should any disputes arise between approved project drawings and these specifications, these specifications will take precedence.

2 QUALITY SYSTEM REQUIREMENTS

2.1 QUALITY ASSURANCE COMPLIANCE

The Contractor shall be required to complete a Quality Assurance Compliance Form at the completion of the works. This form is included in the schedules of this document.

Practical completion will not be given until the completed and signed Quality Assurance Compliance Form has been received by the Superintendent.

The client's expectation is for the installation to be a high quality irrigation system, which clearly meets the client's needs and provides satisfaction with minimal maintenance for many years after project completion.

Such a system can only be achieved through a collaborative approach between the Client, the Designers and the Contractor, however:

FINAL RESPONSIBILITY FOR THE LEVEL OF QUALITY IN THE INSTALLATION DELIVERED LIES WITH THE CONTRACTOR AND HIS INSTALLATION TEAM.

The key elements of the quality system installation expectations are given below.

2.2 QUALITY BENCHMARKS

- The design layout is applied to site features to ensure that the original design integrity is maintained during construction.
- System installation, from initial measurements to final operation, meets the intent of the specification.
- Site clean-up, testing and commissioning.
- Verification that installed system meets design intent.
- As Constructed documentation to the required standard specified in this document.
- Operator training.
- Service/maintenance back-up following practical completion.
- This specification is intended to describe the requirements necessary to achieve the above.

2.3 QUALITY WORK AND EQUIPMENT

All equipment, materials and accessories in this Contract shall be new and shall conform to the appropriate current Australian Standard Specification.

2.4 SITE ACCESS

Before bringing any plant, equipment or materials to site and before commencing any construction operations the Contractor shall liaise with the University for authority to access the site.

The Contractor shall be allowed access to the site during normal working hours. Working hours shall be advised by the Superintendent for each project site.

During installation Contractors shall occupy only such portions of the site as are necessary to carry out the works efficiently. Care must be taken to avoid damage to the grounds, buildings, paths, kerbing, roadways, fences or any other property, landscaping trees or plants. Any damages caused by the Contractor shall be corrected at the Contractor's expense to the University's approval.

2.5 EXISTING SERVICES

The Contractor shall allow for engaging a licenced sub-surface service locating company to determine the exact location of all existing site services, which may not be indicated on the drawings, and he shall conduct his work so as to prevent interruption or damage to them. Damages to existing services shall be repaired at the Contractor's own expense.

2.6 "AS CONSTRUCTED" RECORDS

Will be required as per the relevant section further below in this document.

2.7 HANDOVER

The University of CU shall only take handover of irrigation infrastructure if, at the time of handover, all integrated irrigation works have been completed and are also due for handover.

2.8 CLAIMS

Claims for non-liability of system faults to be directed to the Superintendent.

2.9 STANDARDS AND CODES

The relevant and current Australian or ISO standards will apply to all work conducted in accordance with this specification.

2.10 DESIGN

2.10.1 DRAWINGS

Certified Irrigation Design (CID) drawings (shop drawings) are required to be submitted to the University for approval prior to the commencement of any manufacture or installation.

Drawings submitted for approval are to be:

- in "A1" format;
- in Black and White;
- provided with a legend of symbols where applicable;
- provided in electronic PDF and AutoCAD drawing format; and

- provided as a minimum of two (2) A1 hard copies.

Only CID drawings are acceptable, and all submitted drawings must show current CID approved stamp.

CID drawings shall all be on the same size drawing sheet ("A" size) and shall be to a maximum scale of:

- 1:2000 for site, mainline, and sleeve plans.
- 1:500 for rotor irrigation layouts.
- 1:200 for spray irrigation layouts.

CID Shop drawings shall cover the following parts of the work, where applicable:

- Irrigation piping, material and electrical conduit routes.
- The full extent of any existing infrastructure located externally to the project area proposed to be utilised.
- Any existing services to be anticipated.
- Circuit diagram of sprinkler layout
- Station data table.
- Sprinkler locations and Hydro-zones.
- Schedule of valve locations and flow rates.
- Irrigation control cubicle and pump location.
- Supply current watering program if connecting to an existing system.
- The Distribution Uniformity (DU) with a minimum of 75%.

NOTE: CID drawings are reviewed for general principles of design only and a review of shop drawings by the University of CU in no way relieves the Contractor of his responsibility to comply with the requirements of the Specification, associated drawings and relevant Australian Standards.

2.10.2 APPROVAL

All designs must be submitted to CU for assessment and approval. Installation MUST NOT commence until CU provides approval.

2.10.3 CRITERIA

2.10.4 DESIGN OF NEW SYSTEMS

Sprinklers shall be grouped in accordance with their calculated precipitation rate. Only areas with a matched precipitation rate serving similar plant groups shall be grouped to operate together on a valve section.

Only valves with a similar precipitation rate and serving similar plant groups in a similar microclimate shall be grouped to operate together as a station on the irrigation controller.

Bore licence information, including construction and extraction licencing, proposed construction details, and production pump preliminary selection including make, model, motor size, anticipated installation depth and anticipated duty requirements are to be included with the irrigation system design.

All irrigation systems to be handed over to the University are to ensure the installation does not irrigate privately owned properties and overspray is kept to a minimum as far as is practical.

2.10.5 HYDRAULICS

The Contractor shall select valves and any components required to be attached to the irrigation distribution mainlines so as to be able to operate satisfactorily with a maximum mainline pressure in accordance with the rated working pressure of the irrigation mainline.

The maximum operating pressure not to exceed 650Kpa.

2.10.6 MAINLINE

The Contractor shall accomplish the hydraulic design of the mainline to conform to the following:

- Maintain water velocities in all mainline pipe work to below 1.5 metres per second and/or friction losses to be below 1.5% which ever results in the larger pipe.

2.10.7 SOLENOID VALVES

The pressure loss through any solenoid valve is not to exceed 35 kilopascals.

2.10.8 LATERALS

The Contractor shall accomplish the hydraulic design of the laterals to conform to the following:

- Maintain water velocities in all lateral pipe work to below 2 metres per second.
- Maintain pressure losses in laterals within valve sections to less than 10% between best and worst case sprinklers and of the nominal sprinkler operating pressure of that valve section – especially on extended runs of laterals.

2.11 WATER SOURCE

2.11.1 GROUND WATER SUPPLY

A suitable water source shall be identified, established, tested and confirmed by CU prior to construction of any irrigation system.

The default water source for the irrigation shall be from groundwater resources comprising of multiple bores, pump installations and a network of irrigation mainlines throughout the site. All pumps are controlled by an integrated central pump control system supplied and specifically developed to suit the unique site requirements.

Alternative water sources will require written approval from the University and may only be granted under extenuating circumstances.

As default all reserves, parks and general irrigated areas within the main body of CU's Bentley campus are supplied via an integrated network of centrally controlled bores and distribution mainlines from a superficial aquifer ground water supply.

Satellite areas often have a dedicated bore extracting water from groundwater reserves.

If ground water supply is immediately unavailable permission may be granted to connect to another reserve, or water source in close proximity to the project area. Such permission must be obtained in writing from the University's Irrigation Technical Officer prior to the commencement of installation.

2.11.2 DESIGN AND INSTALLATION OF SCHEME WATER IRRIGATION SYSTEMS

Scheme water supplied systems are not to the University's preferences and permission from the University's Irrigation Technical Officer shall only be granted in extreme circumstances.

Scheme water supplied systems shall comply with the criteria outlined elsewhere in this document with regard to minimum design guidelines and common components. In addition, the following constraints will need to be met.

2.11.2.1 WATER CONNECTION

Should a point of supply (stop-cock, gate valve or meter) not exist, the Contractor shall make the necessary application to the Water Corporation on behalf of the University or the Principal and carry out all liaisons in relation to the provision of the service. The University will pay all costs and charges levied by the Water Corporation if the project is being quoted direct to the University.

In the case of new construction sites, the Contractor shall liaise with the builder for the provision of a take-off point from the main supply to the site. The cost of the take-off point to be included in the total price quoted for the irrigation system.

On existing sites, already serviced with a scheme water services, the Contractor shall arrange, at his cost, for a licensed plumber to install a stop-cock or gate valve as a point of supply for the irrigation system.

2.11.2.2 BACKFLOW PREVENTION

In all instances a backflow prevention device, as required and approved by the Water Corporation, shall be installed immediately downstream of the scheme water take off point. Both the take-off fitting and the backflow preventer shall be housed in an adequately sized, lockable valve box.

All pipe work installed between the take off point, backflow preventer, master valve, if applicable, and the start of the irrigation mainline shall be copper with fittings being copper or brass – all as approved by the Water Corporation.

2.11.2.3 FLOW AND PRESSURE TEST

The Contractor shall carry out a flow and pressure performance test from the scheme water take off point, downstream of all backflow devices and isolation/master valves and use these figures as a basis for design. The Contractor at his expense shall rectify sprinkler malfunction due to inadequate flow and pressure.

2.11.2.4 MASTER SOLENOID VALVE

This shall be a Water Authority approved, 24v AC, tested solenoid valve (or approved equivalent). The valve shall be installed immediately downstream of the backflow preventer and housed in accordance with the specification for the backflow preventer housing. As with backflow preventer, it shall be sized so as to minimize pressure loss.

2.12 HYDROZONING

All designs of irrigation systems are to take into account hydro-zones with different water requirements and/or sprinklers with different operating pressures and/or sprinklers with distinctly different application rates as far as is practical and to the approval of the University's Irrigation Technical Officer.

Sprinklers servicing the following categories of hydro-zones should be valved separately and stationed according to their respective hydro-zones. Indicatively, they are as follows:

- High Profile turf areas.
- Active turf areas.
- Passive turf areas.
- Exotic garden areas.
- Native Garden areas.
- Low passive areas.
- Shaded areas.
- Tree watering systems.

Water from each zone will not over spray on to other zones and may require the installation of two sprinklers next to each other, both set to opposing 180 degrees. Plans submitted for council approval should show the separate watering zones and if required, clarification of watering zones can be determined at this time.

Trees bubblers and garden beds shall be watered on their own individual stations. Active and passive turf areas are to be determined prior to system design.

The design of the system shall be as such to permit the future disconnection of hydrozoned areas if and where required (e.g., road verges/garden beds/TWS) without affecting the balance of the system.

2.13 SPRINKLERS

2.13.1 ARC AND SPACING

The spacing of sprinklers installed in a triangular pattern shall not exceed 40% of their rated diameter. Square pattern installation shall not exceed a spacing of 35% of the sprinklers rated diameter. In disputed cases manufacturers recommendations will be followed.

Sprinklers installed in Road Verges shall be low angle, radius adjustable, commercial sprinklers with a maximum radius of 14m.

Sprinklers installed in median strips shall be installed to minimize overthrow onto roads due to strong winds. Sprinklers shall have a 3m maximum throw and shall be radius reducible by 25% (MINIMUM). Drip shall only be used where written permission from the University's Irrigation Technical Officer has been given.

Sprays are preferred with fixed arc nozzles as far as is practicable.

2.13.2 POP-UP HEIGHTS

Sprinklers in turf shall have nominal 10cm pop-height and be installed with tops approx. 10mm below turf mowing level

Sprinklers in garden:

- Part circles shall be 15cm pop-height.
- Full circles shall be 30cm and or on fixed risers to suit planting e.g. hedges.

2.13.3 PREFERRED SPRINKLERS

- Hunter gear drives I20, I25 and I40 to suit the project.
- Sprays Toro570Z Classic, MPR nozzles with PCD.

2.13.4 RISERS

All gear drive sprinklers in turf to be installed with articulated risers.

Sprays acceptable in EZ-EL Flexipipe or approved equivalent

2.14 PROGRAMMED WATERING TIMES

Watering times to be from 9.00pm to 7.00am.

2.15 WATERING REQUIREMENTS

Unless specified otherwise, design watering requirements shall be based on a peak application of 50mm per week evenly distributed over all surfaces within 40 hours (6 days per week). If the available water supply does not make this possible, the total weekly watering time shall be the minimum possible with the available supply.

Systems designed with a watering time exceeding 40 hours per week must have written University approval before installation commences.

2.16 OVERSPRAY

Overspray will be kept to an absolute minimum on adjoining zones, properties, roads or buildings.

2.17 PRESSURE CONTROL

Where pressure regulation is required on a complete station of sprinklers, and pressure regulation is not an integral part of the sprinkler, this shall be by means of an approved pressure reducing device at the solenoid valve. Where pressure regulation is required on a portion only of a station, a separate pressure-reducing device shall be used.

3 CONSTRUCTION

3.1 PRE CONSTRUCTION WORKSITE INSPECTION PRE REQUISITES: (PERMIT TO DIG)

The company wishing to undertake construction of irrigation systems on CU property including digging/trenching/excavation, needs to apply for a CU Permit to Dig (PTD). No construction work shall be allowed without a valid PTD.

The company will undertake the following activities as a minimum. (The information gathered from completing these activities is required to complete the PTD application)

3.2 DATA COLLECTION FOR EXISTING SERVICES

This task involves a Dial Before You Dig (DBYD) enquiry to establish the known Services in the area where Excavation is planned.

DBYD enquiries can be lodged in one of three ways:

- Lodging online at www.1100.com.au ,or by
- Using the iPhone App, or by
- Ringing the national call centre on 1100 during business hours.

As there are a significant number of activities occurring on the estate. In addition to DBYD enquiry, the Contractor must contact the relevant Curtin University Stakeholders as identified by the Responsible Officer to verify whether other works recently completed or in progress have installed additional Services to those shown on the DBYD data within or adjacent to the proposed Excavation site.

3.3 ACCURATE LOCATION OF SERVICES ON THE SITE

Services disturbed during Excavation fit into three main categories:

- Known Services accurately located.
- Known Services inaccurately located.
- Unknown Services.

The techniques used to identify buried Services need to consider each of these categories to effectively reduce the risk of disturbing buried Services.

There are a number of companies who offer sub surface Service location services, with techniques offered that detect most buried Services with varying degrees of accuracy. Not all types of Service can be accurately identified in all cases (optic fibre is particularly difficult to detect for all current sub surface detection technologies).

It is important that companies wishing to engage a Service Location Contractor discuss the types of Service identified on the DBYD data with the Service Location Contractor so that the level of accuracy available can be correctly factored into the risk assessment process.

As a minimum requirement the Contractor shall allow for a reputable company to perform a Ground penetrating radar (GPR) scan and locate/mark all services, and provide a report/drawings to support the PTD application.

Typical techniques involve the use of various types of detection equipment including:

- Radio detectors.
- Metal detectors.
- Acoustic detection.

Each of these devices can be used to identify the alignment and/or the depth of various types of buried Services.

Vacuum extraction is then used to accurately identify the alignment and depth of the detected Services in the areas where Excavation is planned.

The recommended approach for Service detection is as follows:

STEP 1 - SERVICE DATA IDENTIFICATION

Discuss the DBYD data with a Service Location Contractor and develop a plan to ensure that the most appropriate detection devices are used to best identify the Services known to be on the site.

STEP 2 - EXCAVATION SITE IDENTIFICATION

The extent and location of the Excavation is to be accurately marked on the site using the information provided on the Excavation Location Plan (scale 1:100, A3 size, Coloured Print) required to adequately complete the Permit to Dig/Excavate application.

STEP 3 - SERVICE LOCATION AND MARKING REQUIREMENTS

Each Service shown on the DBYD data and any additional Services information as provided by Curtin University's Representative(s) is to be marked on the site using a system of identification that can be maintained for the duration of the work. High risk Services require an increased number of markers to be installed and greater control on marker integrity and location accuracy.

The Service Location Contractor is to verify that each Service shown on the DBYD data and additional Services information as provided by Curtin University's Stakeholder(s) has been marked on the site and that the markers for each are able to be clearly distinguished from one and other.

Service Crossing Excavation

Where Excavation crosses a Service the markers are to extend sufficiently beyond each end of the Excavation to ensure that at least two markers remain on each side of the Excavation so that the alignment across the Excavation can be re-established at any time during Excavation.

Service Parallel to Excavation

Where Services run parallel to the Excavation, markers should be installed at regular intervals along the entire length of the Excavation and extending at least two markers beyond the extent of the Excavation.

STEP 4 - EXCAVATION PERIMETER SCAN

As the data on Services can contain inaccuracies in content and alignment it is also necessary for the perimeter of the Excavation to be scanned using an appropriate technique to identify if any unknown Service enters the Excavation zone.

Where an Excavation perimeter has a dimension greater than 10 metres in length additional scanning is required within the Excavation area to ensure that unknown Services contained within the Excavation are likely to be detected.

The risk assessment process will define any additional scanning considered appropriate.

STEP 5 - MARKER CURRENCY

As activities on sites can disturb markers it is necessary to validate the accuracy of markers which are older than 30 days. Further where all Excavation activity on site is delayed for longer than five days the Service Location Contractor is to re-confirm the accuracy of markers relevant to the remaining sites of Excavation before Excavation recommences.

3.4 HV & OPTIC FIBRE RUNS

ALL EXCAVATIONS WITHIN 3M OF HV OR FIBRE OPTICAL RUN ALIGNMENTS SHALL BE BY VACUUM EXTRACTION – APPLICATIONS SHALL CLEARLY OUTLINE AND CONFIRM THIS.

3.5 EXCAVATION RISK ASSESSMENT

The Excavation Permit Procedure and the Permit to Dig/Excavate application are designed to guide parties wishing to excavate through a structured risk assessment process.

Additional systems for risk assessment and analysis may also be necessary to effectively mitigate risk, particularly where higher risk Services are involved.

The hierarchy of risk control can be applied to Excavation planning to ensure that all options to reduce likelihood, consequence or both of Excavation causing damage to existing Services are properly considered before work commences.

Control	Test
Elimination	Can the Excavation be avoided completely, the installation delivered above ground?
Substitution	Can the location be altered to avoid Services, or can the depth be adjusted to reduce conflict? Can different Excavation techniques be used to reduce consequences of Service disruption?
Engineering	What barriers can be installed to isolate the Excavation from existing Services? Can the Service be isolated to reduce consequence of disturbance?
Administrative	You must have the required Permits. You must have developed suitable SWMS during Excavation planning.
Personal Protective Equipment	What equipment is required for the workers to Ensure they are not injured during Excavation?

In addition to the Excavation activity itself the type, size location and age of the various Services are important considerations when planning Excavation. It is important to recognise that each site and each set of circumstances represent a different risk exposure and as such each Excavation needs to be properly risk assessed and the relevant controls defined.

Different controls are possible for both likelihood and consequence and the Excavation plan should seek first to reduce:

- The likelihood of damaging Services by ensuring the best data possible is obtained and verified, it is understood and marked accurately on the site.
- The consequence of damaging Services, including isolation or de-energisation of Services, use of less destructive Excavation methods and the development of effective contingency plans should damage occur.

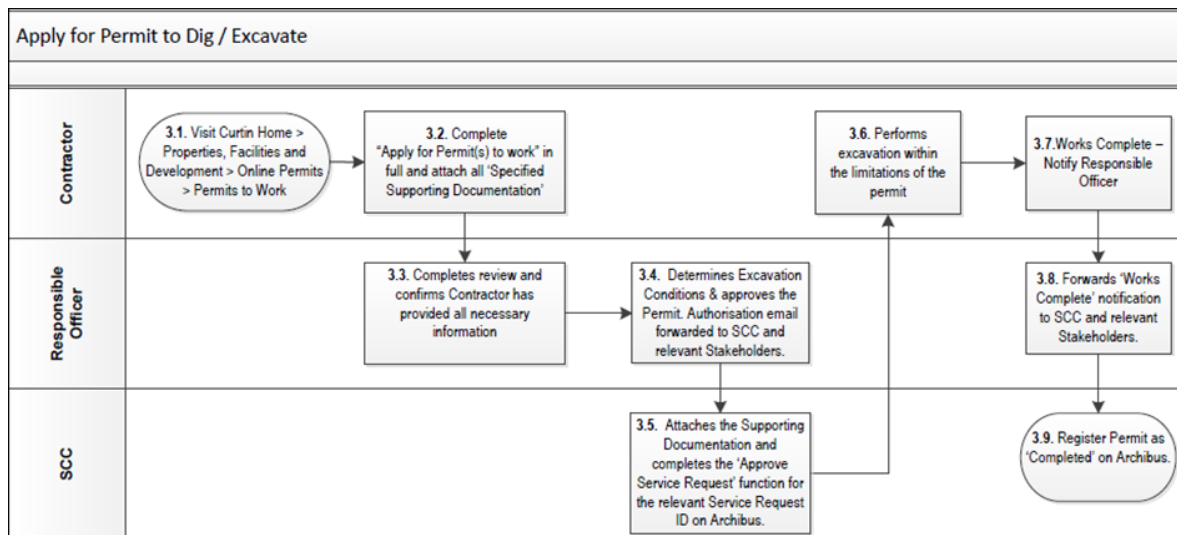
The type of Service to be installed, the depth and type of material in which Excavation is being undertaken, including the likely level of groundwater are all items to be considered in the Excavation risk assessment. The combination of these factors will assist to define the skills required on site during Excavation to ensure that Services are not damaged, and workers remain safe.

3.6 PERMIT TO DIG / EXCAVATE PROCESS

3.6.1 CONTEXT

Curtin University grounds encompass a significant amount of underground services. It is imperative that these services be identified prior to commencement of any works which will disturb the ground. This process may take up to 10 days to complete.

3.6.2 WORKFLOW DIAGRAM



3.7 APPLICATION PROCESS

3.7.1 WEB FORM APPLICATION

COMPLETE ALL SECTIONS OF THE "APPLY FOR PERMIT(S) TO WORK"

Primary Responsibility: Contractor

- The Contractor wishing to undertake the Excavation must complete the application for Permit to Dig/Excavate from the Properties Website: <http://properties.curtin.edu.au/onlinepermits/>

3.7.1.1 ATTACH ALL SPECIFIED SUPPORTING DOCUMENTATION

Primary Responsibility: Contractor

- The Contractor is required to complete all sections of the "Apply for Permit(s) to work" application form. The Contractor must attach all Specified Supporting Documentation and submit the application form.
- Upon submitting the completed online web permit application, the Contractor shall receive an automated notification confirming Curtin University's receipt of the permit application.

3.8 COMPLETE REVIEW AND CONFIRM THE CONTRACTOR HAS PROVIDED ALL NECESSARY INFORMATION

3.9 DETERMINE EXCAVATION CONDITIONS & APPROVES THE PERMIT. AUTHORISATION EMAIL FORWARDED TO SCC AND RELEVANT STAKEHOLDERS.

Primary Responsibility: Responsible Officer (RO)

3.10 ATTACH THE SUPPORTING DOCUMENTATION AND COMPLETES THE 'APPROVE SERVICE REQUEST' FUNCTION FOR THE RELEVANT SERVICE REQUEST ID ON ARCHIBUS.

Primary Responsibility: SCC within Properties, Facilities and Development

3.11 PERFORM EXCAVATION WITHIN THE LIMITATIONS OF THE PERMIT

Primary Responsibility: Contractor

- Upon receipt of the email notification containing the approved Dig / Excavate Permit, the Contractor must ensure that excavation is only undertaken within the limitations as authorised on the Permit.

3.12 NOTIFY CURTIN RESPONSIBLE OFFICER UPON COMPLETION OF THE WORKS

Primary Responsibility: Contractor

- The Contractor must quote the corresponding Service Request ID in the email when notifying the RO that all works associated with the Permit have been completed.

3.13 FORWARD 'WORKS COMPLETE' NOTIFICATION TO SCC AND RELEVANT STAKEHOLDERS.

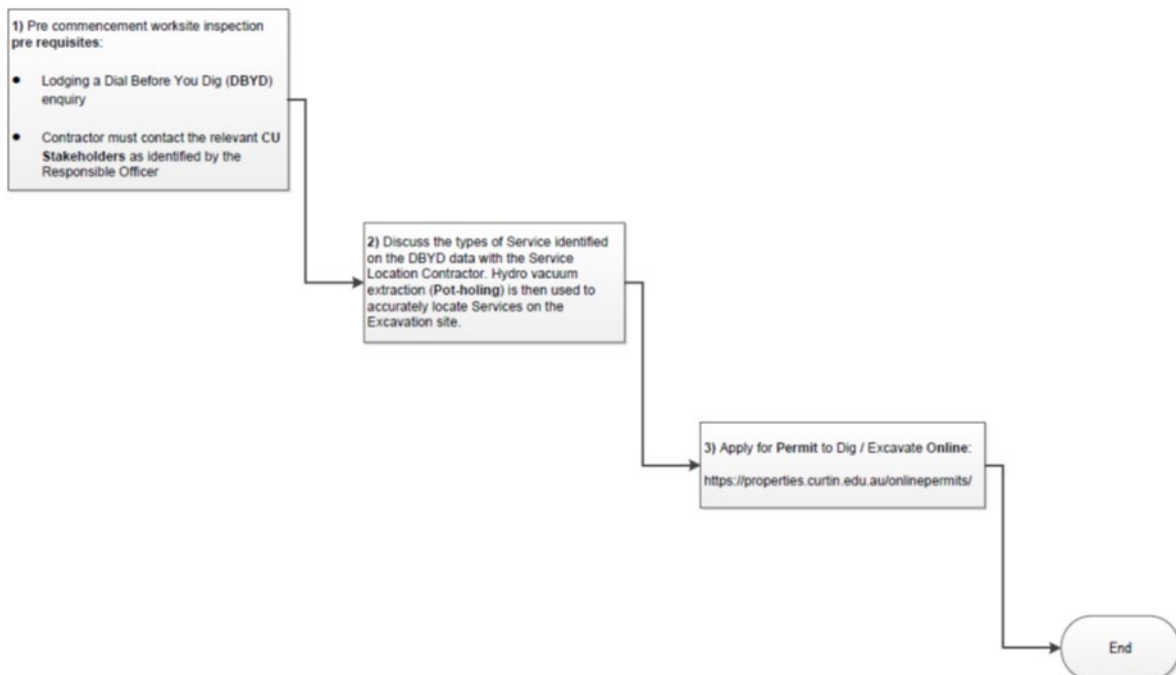
Primary Responsibility: Responsible Officer (RO)

3.14 REGISTER PERMIT AS 'COMPLETED' ON ARCHIBUS.

Primary Responsibility: SCC within Properties, Facilities and Development

Summary:

The below workflow summarises the process of applying for a Permit to Dig / Excavate:



3.15 DIG/EXCAVATE PROCEDURE

3.16 ROLES AND RESPONSIBILITIES MATRIX

LEGEND

Legend	Key	Explanation
R1	Primary Responsibility	Responsible for directly actioning.
R2	Secondary Responsibility	Responsible for monitoring tasks performed by others.

RESPONSIBILITIES	Contractor	Services Protection Officer (arranged & controlled by the Contractor)
Ensuring that for each and every Excavation activity on the Curtin University estate, a person within the company responsible for the Excavation, is to be identified as the Service Protection Officer (SPO)	R1	R2
Ensuring that no Services are damaged during the Excavation activity on the Curtin University estate, performed by the company responsible for the Excavation.	R2	R1
Facilitates an OSH Works Planning Meeting prior to works commencing to discuss OSH risks associated with the contracted works and to determine adequate control processes to deal with risk occurrence.	R1	
Applying for a Permit to Dig and producing all required plans, drawings and Specified Supporting Documentation	R1	
Consulting relevant Curtin University Stakeholders as identified by the Responsible Officer to verify whether other works recently completed or works in progress have installed additional Services to those shown on the DBYD data within or adjacent to the proposed Excavation site	R1	
Forward a 'Works Complete' email quoting the corresponding Service Request ID to the Responsible Officer	R1	
Ensuring that excavation is only undertaken in the approved area and by the excavation method as specified and within the limitations of the authorised Permit.	R1	

Ensuring that Curtin University's backfilling requirements are satisfied	R1	R2
Ensuring that any contractor, sub –contractor, their employees and University staff are aware of the requirement for a permit to dig/excavate, prior to any works being undertaken.	R1	
Proactively monitoring excavation progress, key milestones and identifying risks, and managing specific risk issues	R1	
Ensures the continual protection of new and existing Services during activities following the Excavation including installation of items in any Excavation, the surveying of installed and exposed Services and the operation of backfilling	R2	R1
Familiar with and understands the Excavation permit and the associated SWMS.	R2	R1
Understands what each of the Service markers located on the site relates to.	R2	R1
Has a full copy of the Permit, drawings(s) and SWMS in their possession at all times when Excavation is occurring.	R2	R1
Ensuring presence at the Excavation site 100% of the time when Excavation is occurring.	R2	R1
Directly observing the Excavation (not working in close proximity).	R2	R1
Ensuring the Excavation is suspended if the SPO needs to leave the site even for a short period of time.	R2	R1
Intervening if any activities are likely to cause damage to Services (or) Injury / Death.	R2	R1
Confirming with each other trade involved in the work that they have checked that the actions they plan to undertake will not damage any Service on the site rather than assuming the tradespeople fully understand.	R2	R1
Ensuring prior to backfilling, a Surveyor is contacted to complete a survey of any installed Services and the 'as-constructed' drawings set provided to the RO.	R1	R2
Inspecting and maintaining a contact log of inspections carried out of the works just prior to commencement of the Excavation works and regularly throughout the Excavation – at least once in every 24hrs. The updated contact log is to be provided regularly to the Responsible Officer regularly throughout the Excavation.	R1	

3.17 DIG/EXCAVATE PROCEDURE GLOSSARY OF TERMS

Term	Meaning
Application For Permit To Dig / Excavate	A documented request for an Excavation Permit along with the Specified Supporting Documentation submitted to the Responsible Officer by the Contractor.
Application For Permit To Dig / Excavate Review	A due diligence type review of an Application For Permit To Dig / Excavate completed by the Responsible Officer, the results from which are recorded in the Application For Permit To Dig / Excavate.
Buried / In-ground Services	Electricity, gas, fuel, water, drainage and telecommunications infrastructure that has been installed beneath the ground on the Curtin University Estate.
Close Proximity of High Voltage Electrical Equipment / Authority To Work In The Vicinity Of Electrical Apparatus	Means, for high voltage, locations on installations, where deliberate, accidental or inadvertent contact with electrical equipment is possible, either by a part of the body touching a live part or indirectly through tools, long objects, drills, cutting blades or dropped conducting objects. The definition does not apply if the uninsulated and energised part of the installation has been safely and securely shielded, and protected with barriers or shrouding to guard against unintended contact. Additional consideration should be given if working in HV switchyards with exposed conductors as to minimum clearances required.
Contractor	An organisation that is engaged by Curtin University to perform work on the Estate.
Dig / Excavate Permit	A Permit acknowledged by a Curtin University Representative that is provided following submission of an Application For Permit To Dig / Excavate. No Excavation can take place before an Excavation Permit is issued.
Excavation	<p>Any activity that requires the existing ground to be disturbed to a depth of 150 mm or greater by manual or mechanical means (shovel or machine digging), & includes boring or driving any object into the ground.</p> <p>The following is not considered to be Excavation for the purposes of this Procedure:</p> <ul style="list-style-type: none"> • vacuum extraction for the purpose of service location
Excavation Location Plan	A scaled plan that shows the location of the proposed Excavation on the site in relation to nearby roads, buildings & other infrastructure.
Excavation Details	A scaled plan clearly identifying the proposed Excavation depth below existing ground level
High Risk Activity	Includes High Risk Work described in Schedule 6.3 of the <i>Occupational Safety and Health Regulations 1996</i> and additional

Term	Meaning
(HRA)	Activities that will have an impact on Curtin University's infrastructure, services, operations, staff or students, including: <ul style="list-style-type: none"> • Excavation
Inspection	A process of checking that Workplace physical conditions are at an acceptable standard and that people are undertaking Activities consistent with expectations.
OSH Works Planning Meeting	A meeting, prior to works commencing, facilitated by the Contractor, attended by the Responsible Officer, and if required an OSH representative, to discuss OSH risks & appropriate Risk Management as identified by the Contractor associated with the contracted works.
Permit	Written authorisation to undertake HRA which must be received before proceeding with any HRA.
Permit Applicant	A Contractor representative who submits an Application For Permit To Dig / Excavate Form, along with all Specified Supporting Documentation.
Project Manager	The person managing the project on behalf of the University.
Project Superintendent	The project superintendent nominated in a contract between Curtin University and a third party contracting entity and whose role is defined in relation to that contract.
Responsible Officer	The person nominated to the Contractor as the representative of the University.
Risk	The chance of something happening that will have an impact upon objectives of Curtin University. It is measured in terms of Consequences and Likelihood.
Risk Assessment	A systematic use of available information to determine how often specified events may occur and the magnitude of their consequences. Eg: A buried power line service strike whilst excavating around B-408 could possibly impact the power supply to building 408 including adjacent Cafes and ATMs. This outage will impact on essential services and will render the building inaccessible to staff and students. Contractor to have adequate trades on site to attend to this risk occurrence to ensure business continuity.
Risk Management	The systematic application of management policies, procedures and practices to the tasks of establishing the context, identifying, assessing, treating and monitoring Risk.
Risk Treatment	Selection and implementation of appropriate options for dealing with risk.

Term	Meaning
Safe Work Method Statement (SWMS)	A statement submitted & reviewed by a Contractor that describes the methods that will be applied to complete work safely.
Services	Any existing buried service on or adjacent to the Contractor's site.
Services Location Plan	A Plan to be attached to the Application For Permit To Dig / Excavate which comprises a Service Location Plan for the Excavation Area and with any other services that are identified, marked on the Plan (its location, its diameter, the invert level in the Excavation Area), clearly identifying any difference between the Plan location of identified services and the outcome of on-site service location activities.
Services Protection Officer	A person arranged & controlled by the Contractor, who fulfils the functions of the Services Protection Officer during Excavations.
Specified Supporting Documentation	Supporting documents required to be provided by the Contractor, when submitting the Application For Permit To Dig / Excavate for the High Risk Activity.
Stakeholders	A group who has a stake in the permit procedure and who may be impacted by its outcome. Curtin University's Quick Response Group Manager is a permanent Stakeholder in the permit procedure.
Work Area	An area where Activities are being undertaken by Employees and/or Contracted Personnel.
Work Methodology	A statement submitted by the Contractor that describes the tasks that will be completed as part of the Dig / Excavate Permit.

3.18 DOCUMENT TYPES

Activity Register	A formal list of all Activities.
Form	Logically structured document with a fixed arrangement of captioned spaces, designed for entering, extracting, or communicating the required information.
Plan	Written account of intended future course of action (scheme) aimed at achieving specific goal(s) or objective(s) within a specific timeframe.
Plant & Equipment Register	A formal list of all Plant & Equipment.
Procedure	A fixed, step-by-step sequence of activities or course of action (with definite start and end points) that must be followed in the same order to correctly perform a task.

Process	Sequence of interdependent and linked procedures which, at every stage, consume one or more resources (employee time, energy, machines, money) to convert inputs (data, material, parts, etc.) into outputs.
Process Map	A visual representation of a procedure defining information flows and connections to documents and other procedures.
Program	A plan of action aimed at accomplishing a clear business objective, with details on what work is to be done, by whom, when, and what means or resources will be used.
Report	A document containing information organized in a narrative, graphic, or tabular form, prepared on ad hoc, periodic, recurring, regular, or as required basis.
Review	Orderly recall of past information in summary form for its re-examination.
Risk Register	A formal list of all risks.
Spot Check	Unscheduled inspection at random intervals.
Template	A file that serves as a starting point for a new document.

3.19 EXCAVATION AND TRENCHING

Refer Item 4.4 re HV and FO.

Piping shall be laid in parallel straight lines as far as is practicable. The trench bottom shall be flat, firm, smooth and free from rocks. Care shall be taken so that no rocks, rubble or sharp objects are laid in contact with the pipe. It shall be at the Superintendent's discretion whether excavated spoil is suitable for backfill.

3.19.1 TRENCHING THROUGH EXISTING TURF

The University will indicate areas where trenching through existing turf will require replacement or relaying of turf and which areas will only require backfill.

Where existing turf requires relaying, the turf must be lifted by the Contractor and then replaced after the trench has been backfilled and compacted. Any turf areas removed and replaced must be inspected and approved by a CU Supervisor.

If the turf does not meet CU Supervisors approval then the University may elect to replace the turf with new turf at the contractor's expense. The Contractor is responsible for keeping the turf in good condition until it is replaced.

3.19.2 TRENCH DEPTH

Minimum cover over all PVC pipe work shall be 350mm and maximum depth not greater than 450mm (Exception will be when mainline exceeds 150mm, then minimum cover depth of 450mm / max of 750mm applies).

The trench bottom shall be continuous, firm, relatively smooth and free of rocks, rubble or sharp objects. The pipe should be uniformly and continuously supported over its entire length.

Dripper pipe work shall be buried with a maximum cover of 75mm (including mulch) with polyethylene tubing used to bring the drippers to ground level adjacent to the plant.

3.19.3 TRENCH WIDTH

The trench width shall be sufficient to provide adequate room for joining the pipe in the trench, (if this is necessary) and to allow for the installation of different pipes and conduits within the same trench. The width shall be sufficient to provide a minimum of 100mm space between each pipe or conduit. No pipe or conduit shall be installed directly above or below another pipe or conduit.

3.19.4 TRENCHING PARALLEL WITH ROADS

Under no circumstances will trenching, which runs parallel with the road, be allowed closer than 600mm from the kerb. In the case of lateral lines, sprinklers will need to be offset even though this may not be indicated on the drawing.

3.19.5 ROAD CROSSINGS

Where ducts do not exist, all road crossings must be done by means of horizontal under-road boring.

3.19.6 PIPE EMBEDMENT

The Contractor shall allow for the placement of sand to provide an embedment of 100mm thick (minimum) between the pipe and any unsuitable material. Sand needed for embedding pipes shall be supplied by the Contractor at the installation rates submitted. The Contractor shall provide all necessary labour and plant for the transporting of the material to the trench site and its placement.

3.19.7 BACKFILLING

Excavated spoil may be used as backfill material if free of rocks and deemed suitable by the Principal. Rejected spoil shall be removed from the site and replaced with clean sand at the Contractor's cost. The Contractor shall provide all necessary equipment for the backfilling of trenches, compacting and levelling.

The Contractor shall warrant all trenches against excessive subsidence for a period of twelve months from PC. Any subsidence during the DLP period shall be the responsibility of the Contractor to rectify at his own expense.

The Contractor shall remove all surplus spoil excavation including rocks removed from backfill material from the site.

3.20 SLEEVES

Sleeves or Ducts under road or other hard surfaces and shall be minimum Class 12 uPVC for up to 6m total length. Sleeves exceeding 6m in length shall be minimum PE100, PN10, SDR17, and HDPE.

Sleeves shall:

- Be sized to minimum 2 x combined, bunched diameter of services required to run through the sleeve.
- Extend to a minimum of 1m beyond the kerb or hardscape.
- Be sealed properly at both ends to prevent ingress of foreign material.
- Have AT LEAST 600mm cover.

Any variation from this requirement shall only be at the specific approval of the University of CU.

3.21 MAINLINE IN ROAD RESERVES

It is a requirement that mainline and control valves NOT be installed in medians, road reserves or verges.

Written permission must be obtained from the University's Irrigation Technical Officer for mainlines to connect to any water sources further than 300m from the area of interest. The Superintendent must approve the route and alignment of the mainline prior to excavation commences.

Pressurised mainline will not be accepted in road reserves or median strips.

3.22 IRON FILTRATION UNITS

Where the Contractor wishes to install Iron filtration unit's detailed written application must be made to the University's Irrigation Technical Officer for approval.

Where iron filtration is approved iron filters are to be of an Elliott's Irrigation or Amiad Filtration manufacture or approved equivalent. Installation of the filtration unit shall not be less than 40m from a cadastral boundary. Where a 40m separation is not achievable written permission must be sought from the University.

Backwash from iron filtration units is to be discharged below ground into a serviceable soak well arrangement with minimum Class C trafficable lids in accordance with manufacturer's recommendations and no more than 10m from the site of the filtration unit.

3.23 DOSIN

3.23.1 INJECTION PUMP

The University of CU have a requirement that all active sporting fields irrigated by a groundwater bore are to be serviced by a dedicated dosing pump.

Where dosing pumps are required they are to be of a Grundfos manufacture, model DDA-7.5-16-AR, or approved equivalent. Installation of the dosing pump and all required equipment shall not be more than 10m from the bore headworks and control cabinet.

The dosing injection point shall be immediately downstream of the bore headworks, housed in a lockable jumbo valve box. Where installation is not achievable within a 10m radius written permission must be sought from the University.

The dosing pump shall be housed in a dedicated aluminium cabinet 800Dx800Wx1700H with two 10amp GPO's one for the dosing pump and one for a dual thermostat fan.

The dosing pump shall be operated by an Auto-Off-Manual key operated switch wired such that the following function can be obtained:

- Auto position: Automatically start/stop with a signal from the irrigation controller.
- Off position: All controls are isolated and key is removable.

Manual position: The pump is to be started by push button on/off switches, independent of the irrigation controller and by-passing safety shut down switches.

All suction and discharge tubing shall be a minimum of 6x9 tube, installed in 25mm MD electrical conduit,

The suction tube shall be connected to a two-level sensing foot valve to provide low level and pump shut down signals to the dosing pump unit. The pump unit will be capable of interpreting these signals.

The irrigation mainline pressure normally operates at 550 to 600kPa.

3.23.2 CHEMICAL STORAGE

CU shall provide a 200-litre chemical storage tank to the Contractor, to be located within the ground concrete pit (refer below) located within 5 metres of the pump cabinet.

The Contractor shall install a 1.5mH x ID0.94m Rocla Stormwater Pit or similar as a suitable pit for the storage tank.

The below ground storage pit shall be installed with the cover 100mm above finished ground level and adjacent to the pump location. Final location to be advised by the Superintendent.

The dimensions of the 200-litre chemical storage tank are approximately 580mm diameter by 880mm height.

The below ground storage pit shall be open bottomed with approx. 400mm of coarse blue metal on the floor of the pit, on which the chemical tank will sit. The exact depth

of the blue metal will be determined by the setting for the top of the storage tank when located within the pit.

The pit will be covered using a lockable (padlock), foot trafficable, galvanised steel checker/tread plate cover, with suitable reinforcing beams to allow pedestrian traffic and two retractable lifting handles. The two padlocks will be supplied by CU.

Access to the pit for the pump suction line shall be through a penetration groove in the side of the concrete pit extending approx. 150mm below the top of the pit wall.

3.23.3 ELECTRICAL CONNECTION

Power supply for operation of the dosing pump shall be taken from the power supply to the irrigation pump control cabinet. The power supply to the dosing pump shall be through an on/off isolating switch.

A 4-20ma signal will be taken from the flow meter and connected to the dosing pump which will vary the dosing rate according to the flow rate. The dosing pump will start when flow is sensed and will stop with a no flow condition. The max dosing rate at 20ma will be provided to the successful contractor.

The power supply for the dosing pump will be connected to the bore pump control circuit.

The two-level switch on the footvalve will provide two separate signals to the dosing pump and which will be shown on the dosing pump display when the signals are activated.

One signal will be to show warning of the impending low level of chemical in the tank. The second signal will instigate turning off the dosing pump before the chemical level drops below the safe pumping level, i.e. before the tank is empty, requiring the need to bleed the system after refilling.

All control cables shall be multi-strand copper conductors sheathed in polyethylene or polypropylene and shall be installed in MD electrical conduit.

4 WORKING WITH ASBESTOS CONTAINING PRODUCTS AND MATERIALS

4.1 DEMOLISHED MATERIALS

Material required to be demolished shall become the property of the Contractor and shall be removed from the site.

4.2 ASBESTOS CONTAINING MATERIAL REMOVAL

These clauses cover all work involving asbestos cement products, including removal of asbestos cement pipes.

Note: All persons undertaking such work shall be acceptable to the Superintendent's Representative as being adequately trained and fit to undertake work associated with asbestos cement products. Documentation supporting this requirement shall be submitted to the Superintendent prior to commencement of any work involving asbestos containing products.

4.3 EXTENT OF WORK

The scope of work comprises the following:

Removal and disposal of existing asbestos cement pipework, excavated during construction of the new system, providing that the pipework is not being integrated with the new system.

4.4 CONSULTATION

Note: No asbestos related work is to commence until the Superintendent's Representative and building authorities have been consulted. Prior to commencing any work involving asbestos products, the authorities of the building shall be consulted with regard to the extent of the work and the work practices to be used.

A handover meeting WILL be required. This will be organised at the project start-up meeting in consultation with the Superintendent. Those attending the meeting may include the Superintendent, designated Representatives and D.O.S.H.W.A. representatives.

4.5 NOTICE OF COMMENCEMENT

Give a minimum of two (2) working days' notice in writing to the Superintendent's Representative prior to commencing any work involving asbestos products on site.

No work shall commence until approval to proceed in writing from the Superintendent's Representative has been given.

4.6 INSPECTION PRIOR TO AND DURING DEMOLITION WORK

Upon notice being given by the Contractor, the Superintendent's Representative will arrange for representatives of the appropriate organisation to supervise and inspect the asbestos removal work both prior to commencing the work and during the course of the work. The Contractor is to allow reasonable access to the site for such personnel at all times. The Contractor shall advise the Superintendent's Representative at the time of completion of each phase of asbestos work so that an inspection by such personnel can be arranged to ensure that demolished asbestos products have been removed in accordance with the requirements of the relevant Authorities.

4.7 HOURS OF WORK

All asbestos removal work is to occur outside of school operating hours so as not to interfere in any way with the normal operations of the school.

4.8 CODES AND REGULATIONS

All asbestos cement related work shall be done in accordance with the following codes and regulations and the DHW Asbestos Cement Work Practice Sheets 1 to 13 (listed below)

Occupational Health Safety and Welfare Act 1984

Occupational Health Safety and Welfare Regulations 1988

National Occupation Health and Safety Commission - Worksafe - Asbestos Code of Practice and Guidance Notes.

Health Act 1911 - Health (Asbestos) Regulation 1992.

Dangerous Goods Regulations 1992 - Australian Code for the Transport of Dangerous Goods by Road and Rail.

DHW Asbestos Cement Product Work Practice Sheets.

Practice Sheet 1	Work Areas Signs and Barriers
Practice Sheet 2	Clean Up of Work Areas
Practice Sheet 3	Disposal of Asbestos Cement Waste
Practice Sheet 4	Access to Asbestos Cement Roofs
Practice Sheet 5	Accessing Ceiling Spaces
Practice Sheet 6	Cleaning Gutter, Drains and Sumps
Practice Sheet 7	Working on Asbestos Cement Products
Practice Sheet 8	Removal of Asbestos Cement Products
Practice Sheet 9	Painting of Asbestos Cement Products
Practice Sheet 10	Cleaning of Asbestos Cement Eaves

Practice Sheet 12 Collecting Asbestos Cement Samples

Practice Sheet 13 Approved Vacuum Cleaners

4.9 WARNING SIGNS

Prior to commencement of any work ensure that warning signs and barriers as required by DHW Asbestos Work Practice Sheet 1 are in place.

4.10 PERSONAL PROTECTIVE EQUIPMENT

All workers engaged on asbestos related work shall wear protective clothing and respirators at all times on site as required by the current regulations.

4.11 USE OF TOOLS

No power tools shall be used to cut, grind, drill, and saw on any asbestos containing products.

4.12 MONITORING EQUIPMENT

Air monitoring equipment if required, shall be approved and located as required by D.O.S.H.W.A. is to be maintained and operated during the period 1 day before commencement of asbestos removal until 1 day after approval of completion at the Handover meeting described in 204(b) above.

4.13 CLEAN UP OF WORK AREAS

All work areas where work on asbestos cement products have been undertaken shall be properly cleaned and hosed down to prevent asbestos, containing fibres, spreading.

No barriers or signs shall be removed until the work site has been completely cleaned to the satisfaction of the Superintendent's Representative.

All external exposed surfaces that may have been in contact with the asbestos material shall be properly hosed down e.g. paths, etc.

4.14 VACUUM CLEANERS

Use of vacuum cleaners shall be approved for use with asbestos fibre.

4.15 UNDEFINED ASBESTOS CONTAINING MATERIALS

Following discovery of any materials suspected of containing asbestos (other than asbestos cement) during the course of the works the following shall apply;

Inform the Superintendent's Representative immediately.

4.16 INSPECTIONS

Provide and set aside 2 sets of disposable coveralls with P1 or P2 type respirators for use by CU Personnel, D.O.S.H.W.A Representatives or other persons nominated by the Superintendent.

4.17 COMPLETION OF ASBESTOS REMOVAL

A. This clean-up work MUST be completed as quickly as practically possible after exposure of any Asbestos Cement pipework or Asbestos containing material.

5 SUPPLY AND CONSTRUCTION OF NEW IRRIGATION SYSTEM

The Contractor shall warrant that all materials shall be of a high quality and free from defects. All equipment supplied and installed shall be accomplished in accordance with standard industry practice and equipment / material manufacturer's recommendations and specifications.

Accordingly, the Contractor shall warrant that all equipment and materials are guaranteed by the manufacturer of the materials for a minimum period of 12 months from the date of Practical Completion of the project works.

All materials, equipment and work shall comply with the appropriate Australian Standards, specification or code, and must conform to the University's Irrigation Specifications and / or shall comply with the relevant rules and regulations laid down by any statutory authority having jurisdiction over such work and shall conform to the requirements of insurance underwriter's code.

The Contractor shall take all necessary precautions with the supply and installation of equipment specified to prevent damage to components. Any component showing signs of damage during the Maintenance Period shall be renewed or otherwise made good in an appropriate manner.

In addition to the equipment and material guarantees, the Contractor shall warrant his workmanship for a minimum period of 12 months from the date of Practical Completion of this project, and shall agree to undertake to correct any problem which may occur which is attributable to poor workmanship or failure of any materials, equipment or part thereof, during the guarantee period where such equipment and materials fail to perform the duty for which they were designed. The removal, repair and/or replacement of any such materials and equipment shall be undertaken by the Contractor, at no cost to the Principal.

5.1 SETTING OUT

The Contractor shall do all setting out in accordance with the Drawings. Any site anomalies should be brought to the University's representative prior to commencing work.

The Contractor shall peg out each run of pipes and sprinkler heads prior to trenching. Before installation commences in any given area, the Superintendent shall check out all locations and give his approval.

Where irrigation is to be installed in active playing fields the contractor shall allow to engage a licenced surveyor to mark sprinkler and valve locations.

5.2 IRRIGATION PIPES

All piping installed shall be manufactured in Australia to the current Australian standard i.e. HDPE or uPVC.

Connections and piping installations shall be in accordance with the manufacturer's recommendations and must comply with the relevant Australian Standard Codes of Recommended Practice.

All piping shall be installed within 18 months from the date of manufacture.

5.2.1 MAINLINE PIPES

All mainline piping shall be a minimum of PN12.5 HDPE pipe, joined by either butt weld and/or electrofusion methods.

All pipe joints shall be made by competent, experienced, qualified, certified operators using calibrated welding equipment – calibrated within 12 months before. Proof of the above will be required.

No pipe joins or fittings shall be accepted in sleeves or on under road crossings. Mainline through sleeves or under roads shall be a continuous length of PE100 PN12.5, SDR13.6, HDPE of equivalent diameter and approved diameter. HDPE with butt welded flanges one either end shall extend a minimum of 1m beyond the extent of the sleeve or road crossing for connecting further pipework.

Mainlines are not to be installed under any fixtures such as footpaths, play equipment etc. and shall not be installed in any drainage swale at a distance of greater than 1m from the swale top edge.

5.2.2 PVC LATERALS

All lateral piping shall be a minimum of Class 9 uPVC. Laterals of 80mm or less in diameter and shall utilize the Solvent Weld method of jointing (SWJ), laterals greater than 80mm in diameter shall be RRJ.

5.2.3 PVC FITTINGS

All fittings used in the installation must be new, compatible with the pipes used and manufactured to AS1477.2-1990, AS1477.5-1988 and AS1477.6-1989 and shall be compatible with PVC pipe produced in accordance with the standard. PVC fittings shall be manufactured to Class '18'.

Changes in direction of pipe work shall be with standard fittings. Excessive bending of the pipes will not be permitted. The crossing of fittings shall under no circumstances be allowed.

All outlet BRANCHES OF TEES SHALL BE INSTALLED IN THE HORIZONTAL PLANE.

5.2.4 PRIMERS, SOLVENTS, RUBBER RINGS AND LUBRICANT

Primers and solvents used for the piping connections shall be of approved manufacture and shall be used in accordance with the manufacture's recommendations. All solvent weld connections must be clean and have no excess solvents outside the joint. Cleaners must be coloured.

Rubber rings supplied for pipes and fittings shall comply with Australian Standards AS1646 - 1992. The supply of pipe and fittings shall include a ring lubricant as recommended by the manufacturer of the pipe or fittings.

5.3 BENDING OF PIPES

The bending of pipes will not be accepted unless written permission has been given by the University's Irrigation Technical Officer.

Where approval has been granted pipe bends shall not exceed the manufacturer's recommendations for the material, class and diameter of pipe being bent.

5.4 THRUST BLOCKS

Thrust blocks on non-self-restraining fittings and pipes, shall be constructed in accordance with the Plastic Industry Pipe Association's installation instructions and shall be constructed symmetrically about the centre line of the fitting. The pipe or fittings shall be covered with a protective membrane of PVC when adjacent to concrete.

Concrete shall be thoroughly mixed on the surface prior to installation. Dry concrete mix and water shall not be mixed in the trench. Locations shall be determined on site and suit the ground conditions, but it can be assumed that thrust blocks shall have minimum dimensions of approximately 600 x 600 x 600mm.

All thrust blocks must be installed in relation to pipe sizes and not be deemed excessive, any excess concrete must be removed from site. The irrigation contractor shall provide all materials and concrete for the thrust blocks.

Thrust blocks shall be installed on all RRJ mainline fittings, including elbows, bends, reducers, tees and isolation valves, but excluding 'self-straining' take-offs such as tapping bands for air valves and tees to solvent welded branches for sub-mains.

Thrust blocks shall be so placed that the pipe joint will be accessible for inspection and repair. Concrete for thrust blocks shall be placed against undisturbed soil faces. All sides of thrust blocks not in contact with undisturbed soil shall be formed.

5.5 SPRINKLERS

Refer to Item 3.4.

5.5.1 SPRINKLER INSTALLATION

All sprinklers shall be installed as per manufacturer's specifications.

5.5.2 ROAD VERGE SPRINKLERS

Gear driven sprinklers installed on road verges shall be offset 300mm from the back of the concrete kerb.

Domestic type sprinklers installed on road verges shall be offset 100mm from the back of the concrete kerb.

5.5.3 SPRINKLER HEIGHT

All sprinklers shall be installed as per the manufacturer's instructions and University of CU standard drawings.

The Irrigation Contractor shall be responsible for ensuring all sprinkler heads fully retract when not in operation and non-drain valves operate correctly to prevent line damage.

Any changes to the height of the sprinklers caused by subsidence of trenches shall be rectified by the irrigation Contractor.

The Irrigation Contractor shall allow for returning to the site after establishment of turf grass and adjust sprinkler heights where necessary.

5.5.4 GEAR DRIVE SPRINKLERS

These shall be pop-up sprinklers with stainless steel risers (nozzle turrets) and built in non-drain valves.

The sprinklers shall be installed on articulated risers of sufficient length to maintain the specified pipe cover when installed at 45 degrees to the horizontal. Risers to be same diameter as the inlet thread on the sprinkler.

Rotors are the University's preferred method of irrigating turf, and the preferred rotor brand is Hunter. The use of low volume nozzles, or alternative brand rotors shall require written approval from the University's Irrigation Technical Officer.

Alternative sprinklers may be considered for approval should particular circumstances warrant.

5.5.5 SPRAY SPRINKLERS

Where circumstances dictate the use of domestic type sprinklers, the University's preference is for Toro 570Z series with flow restricting shut off action should nozzle damage occur. The use of alternative brand spray sprinklers shall require written approval from the University's Irrigation Technical Officer.

Sprinklers installed in lawn areas shall be of the spring retractable, pop up type with a minimum pop up height of 75mm. MP Rotors are generally not acceptable for turfed areas, exceptions must be approved by the University's Technical Irrigation Officer.

Sprinklers that are installed in garden beds shall have a minimum pop up height of 150mm where installed against pathways, paved areas, roadways, and backing onto turfed areas. Elsewhere they shall have a minimum pop up height of 300mm.

5.5.6 BUBBLER TYPES

In the case of bubblers, they shall be of the pressure compensating, fixed flow type.

Sprinklers and bubblers shall be installed on Toro brand 570Z series pop-up bodies and screwed polyethylene articulated risers.

Multiple bubblers per tree to suit the plant may be required to tree plantings and root ball size.

5.5.7 DRIP AND SUBSURFACE SYSTEMS

The installation of drip is NOT the preferred irrigation method and, permission to install a drip system must be obtained from the University in writing. Subsurface is NOT to be installed under turf areas.

Subsurface irrigation systems shall comprise of Netafim pressure compensating inline dripper pipe with anti-siphon ability and copper oxide impregnated diaphragm.

The subsurface lines are to be installed at a maximum of 300mm spacing's and at a rate nominated to provide the required precipitation rate to the planted garden beds whilst not exceeding the manufacturer's maximum length of drip line and to maintain an application uniformity of 90% and/or maximum frictional pressure loss representing the difference between the operating pressure and minimum operating pressure of the emitters as recommended by the manufacturers.

Subsurface irrigation shall be installed at a depth of 75mm inclusive of mulch. The subsurface laterals are to be pegged with steel pegs 300mm in length at a maximum of 2m centres along each drip line run.

All solenoid valves providing irrigation water to areas of drip irrigation shall be fitted with a valve sized plastic bodied filter unit incorporating a disc filtration element equivalent to 120-mesh filtration. The system shall incorporate a line sized nylon ball valve located prior to the inlet of the filter and installed below ground level within a plastic valve enclosure. The filter enclosure to be sized so that filter may be easily maintained (JUMBO Valve box).

Where drip tubing is to be installed under mulch or buried directly in the soil, the contractor shall include a minimum of DN40 PVC or DN50 PE pipe to form a manifold for all of the drip tubes for both ends of the tubing, as follows:

- A water supply manifold connected to the drip irrigation filter and solenoid valve assembly.
- A water collection (drain) manifold connected to the downstream ends of all drip poly tubing runs.
- All ends of the water supply manifold shall be fitted with manually operated flushing valves.
- At least one end of the collection manifold shall be fitted with a manually operated flushing valve.
- At least one end of the collection manifold shall be fitted with an automatic drain valve.
- Air release valve shall be fitted at the highest point in the water supply manifold.
- Generally, all drain valves shall be installed at the lowest point of a drain manifold.
- Vacuum & drain valves may be interchanged, to suit the relative ground levels at the installation, the intention being that upon closure of the solenoid valve, air is allowed to enter the tubing at the high point and water is allowed to drain from the low point. All vacuum breaker valves, flushing and drain valves shall be housed within a 1910 valve box.

5.6 MAINLINE CONNECTIONS

Solenoid valves up to and including 50mm in size shall be installed on the mainline by means of MILNE gunmetal tapping bands or STOCKBRANDS Noral Construction tapping bands with stainless steel bolts & nuts or University approved equivalent. The tapping outlet size MUST be the same size as the solenoid valve. Solenoid valves 80mm and larger shall be installed on A.W.E NORTITE, BSP tapped, rubber ring joint tees.

In the event of non-availability of the specified take-off fittings, the University must be contacted for advice on acceptable alternatives. Where domestic sprinklers or drippers are used, pressure to these must be controlled either with the use of pressure regulating solenoid valves or separate pressure regulators.

Where threaded (BSP) pipe fittings are to be utilised to facilitate the connection from the mainline fitting/tapping to the solenoid valves they shall be manufactured from brass or copper. They shall be rated at a maximum working pressure of 1600 kPa (PN16) as tested by the manufacturer in accordance with AS1460-Part 1.

All threaded joints of control valves and associated fittings shall have their threads sealed with Teflon sealing taped to prevent leakage.

5.7 SOLENOID CONTROL VALVES

Solenoid control valves shall be Bermad Series 100 or 200, normally closed, 24 volt A.C., 50-cycle solenoid coil operated diaphragm valves.

As a minimum the solenoid control valve shall comply with the following features:

- Installed with a TII SD Systems 2-wire smart decoder coil.
- Female B.S.P. threads for valves up to 50 mm diameter.
- 65 mm diameter valves are not to be supplied.
- Bonnet of valve larger than DN 25 to be secured by nuts, not screws.
- Manual control stem for flow adjustment.
- "Bleed" water to discharge internally (during automatic operation).
- Manual open/close control.
- Corrosion resistant internal components.
- Low power requirements; inrush current not to exceed 0.42 amps.
- Minimum operating pressure of 1000 kpa or greater.
- Reinforced plastic body or metal construction.

Installation of solenoid valves shall comply with the following:

- Top of valve to be located a maximum depth of 350 mm below finished ground level.
- A clearance of 100 mm minimum between top of valve (flow control stem) and the underside of the valve box lid.
- A clearance of 100mm minimum between the base of the valve and the base of the valve pit.
- Housed in a reinforced lockable plastic valve box of suitable size to allow for maintenance.
- Solenoid valves shall be positioned within valve boxes to provide best access for maintenance.

- Solenoid valve assemblies are to be installed in grassed or garden areas approved by the superintendent.
- Solenoid valve assemblies shall not be installed within 5m of active playing areas, this means whenever possible valves will be located to the sides of large turf areas.

Valves are not to be located outside property boundary lines, if applicable to the site and scope of work under contract. No valves are to be installed in active sport playing areas. If valves need to be installed in close proximity to active turf areas approval must be sought from the University's Irrigation Technical Officer.

Valves are not to be located within drainage swales.

A Philmac isolating ball valve, the same size as the solenoid valve, must be installed immediately upstream (prior) of the solenoid valve.

The control valves shall be located adjacent to the mainline but a minimum of 700mm of straight pipe is to be provided downstream (sprinkler side) of the valve assembly to allow for future servicing. No quick fixes, threaded couplings or Milnes e.g. shall be used on new installs within 6 Mt of valves unless approved by the University's Irrigation Technical Officer.

5.8 AIR RELEASE VALVES

Fully "automatic" air release valves shall be installed at, and above, all mainline high points and to manufacturer's recommendations. "Snifter" valves are not acceptable.

Installation of Air release valves shall comply with the following:

- Top of valve to be located a maximum depth of 350 mm below finished ground level.
- A clearance of 100 mm minimum between top of valve and the underside of the valve box lid.
- Housed in a reinforced lockable plastic valve box of suitable size to allow for maintenance.
- Air release valves shall be positioned within valve boxes to provide best access for maintenance.
- Air release valve assemblies are to be installed in areas approved by the superintendent.

5.9 MAINLINE ISOLATION VALVES

These shall be AVK Resilient Seal (or equivalent approved) sluice valves, sized as per the mainline i.e. 100mm valve for a 100mm mainline.

Mainline isolation valves shall be installed at junctions of mainlines as shown on the project drawings. Price for installation of valves shall include the installation of valve boxes. Access to valve assemblies located below the bottom of valve boxes shall be provided by the installation of a short piece of 250mm nominal diameter PVC 'Ribloc' pipe or equivalent.

Isolation ball valves installed on the inlet to solenoid control valves and on mainline up to 50mm diameter shall be Philmac nylon ball valves or approved equivalent.

On 80mm and above mainline size use ductile iron resilient seated valve with spindle cap. Valves shall be configured for 'clockwise turning' to close and the top of the spindle cap shall have an embossed arrow indicating the direction to turn for closing. Note: Non-conforming valves shall be replaced at the irrigation contractor's expense. Valves shall be configured for table "C" flange mounting and shall be enclosed in a valve box as specified.

The irrigation contractor shall supply one 665mm valve actuating key with 'T' handle for use with any new mainline isolating valves installed.

Where the spindle caps are different sizes on any given site, a valve actuating key will be provided for each size of cap at that site.

The irrigation contractor shall allow for adjusting valve box heights after the re-establishment of turf.

5.10 MAINLINE FLUSHING VALVES

These shall be 50mm Philmac manually operated valves, or similar approved by the University's Irrigation Technical Officer. They shall be installed into the mainline by means of a tapping saddle at the termination of mainline runs such as to allow for 0.5m of capped mainline beyond the flushing valve connection.

5.11 VALVE BOXES

5.11.1 MARKER BALLS

All valve boxes shall be installed including a PURPLE 3M EMS ID BALL MARKER 1428-XR/ID general purpose/recyclable programmable ball marker.

The Contractor shall supply CU with uncoded PURPLE 3M EMS ID BALL MARKER 1428-XR/ID for general purpose/recyclable water for each solenoid valve box. The Superintendent shall supply coded ball markers to the Contractor for installation in each valve box as is required in exchange for new uncoded balls.

5.11.2 VBS IN SOFT LANDSCAPE

Valve boxes/cable pits/isolation valve access boxes shall be located in turf areas as far as is practical. Approval from the Superintendent must be sought for deviation from this requirement.

Rainbird MDPE and HR Hydrant Cover (Body only) valve boxes without pipe portals shall be supplied, with overlay style lockable lids with stainless steel locking bolts. Valve boxes shall be the following models:

Rainbird VB-STD shall be fitted to all in ground solenoid valve/flush valve assemblies located within garden/beds, where practical.

HR Hydrant Cover (Body only) shall be fitted to all in ground solenoid valve/flush valve assemblies located within turf/lawn, where practical. CU will provide the lid to the Contractor for installation.

Rainbird VB-10RND- To be fitted to all isolation valves and cable pits.

Rainbird VB-MAX valve boxes will be required at all solenoid valves serving TWS systems that require the installation of a pressure regulating device.

VB-JMB SERIES valve boxes may be used on prior approval by the Superintendent.

CU prefers the doubling up of VB-STD valve boxes to accommodate the solenoid valve assembly and the control conduit/cablings where practical.

All valve boxes shall be installed on at least one course of unmortared bricks or similar and allow servicing of valve without removal of the valve box.

Valve boxes may be stacked to allow for depth of soil where required.

Valve boxes with pipe access holes shall not be used, unless the access hole is required for the installed configuration for any given valve.

Valves shall be centrally located within the valve box and the valve shall be clearly exposed within the valve box. All excess sand and soil within the box will be removed by the irrigation contractor.

Adequate clearance shall be provided between the top of the valve and the valve box lid underside.

5.11.3 VBS IN HARD LANDSCAPE

Isolation valves located in hardscapes shall be fitted with UNMARKED Conical SV Covers.

Covers shall be 230mm H, 163mmØ at the top and 267mmØ at the bottom. Products as supplied by Dobbie, product code 2CV1000 or approved similar shall be accepted. Marked covers (especially WaterCorp) shall not be accepted.

SV Covers shall be installed on a concrete support base as per the installation detail.

5.12 IRRIGATION CONTROL SYSTEM

5.12.1 CONTROLLER

CU use TII SDS controllers. The specific location and models have to be confirmed with CU irrigation staff by the Contractor before any works commence.

5.12.2 EXTRA LOW VOLTAGE IRRIGATION CONTROL WIRES - TWO WIRE SYSTEM

The Contractor will allow to supply and install new two wire cable to the extent of Works and make connections to all solenoid valves.

For SDS two wire control systems at Curtin University the two wire cables shall be as specified and approved by the manufacturer of the SDS control system. Any new two wire path installed will include surge suppressors as recommended and approved by the controller manufacturer.

New 2.5mm² decoder cabling according to the manufacturer's specifications and requirements shall be installed in conduit.

5.12.3 INSTALLATION AND HANDLING

Care shall be taken at all times when laying cables not to drag, skin, kink, etc. any wires. Cables shall be neatly bundled and taped at approximately 6 metre intervals.

During hot weather cables shall be 'snaked' into trench to allow for contraction. A surplus loop of approximately one metre in length shall be neatly looped and placed alongside each solenoid valve to allow for future servicing.

The decoder numbers shall be recorded during the construction process to simplify compiling the valve wiring chart for the 'As Constructed' drawing.

5.12.4 WIRE CONNECTORS

All solenoid cable joints shall be fitted with a crimp and sealed with a 3M DBYR or Blazing Products BVS2 Snaplock connector. Alternative sealant kits shall not be used unless authorised by the Superintendent.

Wire connections to solenoid coils and joints in cables shall only be carried out by competent and experienced tradesmen.

The Solenoid wire shall be taped to the lateral pipe work adjacent to the valve and the wire shall be looped (minimum 1.5m loop) in the valve box to allow flexibility in future maintenance works.

Ends of wires shall be stripped by the use of correct wire stripping methods and tools.. Similarly only approved crimp pliers shall be used on crimp sleeves.

It is important that all joints be absolutely waterproof so that there is no chance of leakage of water and corrosion build-up on the joint. The specified sealant kits shall be used on ALL cable joints.

The number of in-ground joints shall be kept to an absolute minimum. The irrigation contractor shall utilise his cable drum lengths and off-cuts in a manner that will permit continuous cable runs from the controller to solenoid coils. Any cable joints not located at solenoid valve coils shall be made in an approved electrical cable pit and recorded on the 'As Constructed' drawings.

All cable joints shall be to the approval of the Superintendent. Pairing of cables shall only be made at the controller or the adjacent terminal strip.

Where the two wire cable is extended to terminate at a location other than a solenoid valve the ends of all spare wires shall be sealed in a DBYR connector.

The ends of all spare conduits shall be capped and sealed to prevent the ingress of dirt, soil and insects.

5.12.5 CONDUIT

All solenoid wires shall be installed in MD conduit. The ends of the conduits shall be sealed to prevent the ingress of dirt and insects.

Where not specified all conduit for extra low voltage (24 VAC) control wires shall be a minimum of DN40 MD Grey conduit.

Spare conduits shall be terminated with a 90° elbow set vertically in the valve box, with a short piece of vertical conduit with the end capped.

Cable ends may be extended into the valve box using a 500mm (minimum) length of flexible conduit if required. Joints between PVC and Flexible conduit shall be secured by clamps. Duct tape shall not be accepted.

5.12.6 CABLE PITS

Cable pits to be P5 - PE pits supplied with precast concrete lids marked as "Irrigation."

Cable pits shall be installed at all changes in direction and/or 100m continuous run. Conduit terminations to be in cable pits unless directed otherwise by the Superintendent.

The top of the pit shall be set level and flush with the finished ground surface level.

5.12.7 LIGHTNING STRIKE AND SURGE PROTECTION

All lightning protection must be installed as per controller manufacturer's specifications as a minimum. The two-wire path and all field communication equipment shall be fitted with adequate filtering equipment and protection to safeguard the unit from power surges from both the power supply and field wiring input sides.

The surge protection provided shall be greater than the maximum level of protection recommended by the manufacturers of the two-wire system, the University will not accept lower protection levels than to cover the shorter distance of 8 decoders or 250m of cable run. Surge protection devices to be housed in adequately sized, lockable plastic valve boxes.

5.13 WATER METERS

These are to be Siemens Mag 5000 series water meters sized to suit the bore discharge headworks. Meters shall be capable of monitoring and storing collected data as a minimum requirement. All flow meters shall have the ability to record and display the following information:

- Flow Rate in L/sec.
- Re-settable cumulative flow volume in cubic meters.
- Non re-settable cumulative flow volume in cubic meters.
- A remote display installed within the control cabinet.

Water meters are to be installed in the bore discharge headworks prior to the testing tee and in accordance with manufacturer's specifications and located as per University of CU's Technical Irrigation Officers approval.

All flow meters shall be installed in a lockable galvanised box to protect from vandalism and tampering.

All flow meters shall be installed with a remote readout located in the electrical control cubicle. The normal design flow for the flow meter will be set to deliver an output pulse midway between the 4-20mA range.

6 ELECTRICAL SPECIFICATION

6.1 GENERAL

The works comprise the provision, installation, testing, commissioning and maintenance of the Electrical Services required for the nominated site.

Whether or not the words "provide," "supply" and/or "install" appear in the tender documents, all equipment for the complete installation shall be provided and installed by the Irrigation Contractor's Electrician.

All workmanship and materials shall be in accordance with S.A.A. wiring rules AS3000 of 1981 or subsequently revised editions. In addition, the electrical installation shall comply with the State Electrical Act, Local Supply Authority requirement and Uniform Building by-laws.

All equipment, material and accessories supplied by the Contractor in this Contract shall be new, shall conform to the appropriate current Australian Standard.

Where a trade name, brand and/or catalogue number is referred to in this Specification the Contractor shall include such products or seek written approval from the University's Irrigation Technical Officer for alternatives.

Only products which have been commercially available for a minimum period of twelve months and have been proven in the Western Australian market place shall be used.

All materials specifically required shall be supplied by the contractor.

6.2 ELECTRICAL CONTRACTOR

All work shall be carried out by a suitably experienced Electrical Contractor employing licensed Electricians. Because of the critical need for reliability and a comprehensive understanding of motor pump performance characteristics, the Contractor shall only sub-contract the design and construction to an Electrical Contractor who has had previous experience with pump controls.

6.3 REGULATIONS AND STANDARDS

The installation and materials provided shall comply with the relevant rules and requirements of the following, including payment of all and any fees required:

- The Supply Authority (Western Power), including compliance with the latest issue of Western Power electrical requirements.
- Electrical Act and Regulations.
- Occupational Health, Safety and Welfare Act & Regulations.
- Local Authority.
- Australian Standards.
- AS3000 SAA Wiring Rules.
- Pay all fees due to the above Authorities.
- Any other Authority having jurisdiction over the works.

- The latest edition of the Standards, Rules and Requirements current at the time of calling tenders shall apply.

6.4 DISTURBANCES IN MAINS SUPPLY NETWORKS

Electrical equipment shall comply with AS2279 Disturbances in Mains Supply Networks, including limitation of voltage fluctuations and harmonics.

6.4.1 ELECTROMAGNETIC INTERFERENCE

Electrical equipment shall comply with limits of electromagnetic interference defined in AS2064 to Class B.

6.4.2 EXISTING SERVICES AND ASSOCIATED EQUIPMENT

There may be other existing services in the area.

The Contractor shall immediately repair any existing systems not within the area of modification, damaged during constructing of the new system. These works shall be at the Contractors expense.

6.5 EARTHING AND BONDING

Earthing in all instances shall comply with the full requirements of AS/NZS 3000:2018 and or subsequently revised editions, WA Electrical Requirements and local supply authority regulations and contractors' guides.

Size of earth conductor installed with pump cables shall be sized in accordance with AS/NZS 3000:2018 and WA Electrical Requirements. Earthing conductors inside switchboard, switchgear, terminal boxes or GPOs. enclosures and anywhere in the vicinity of live metal shall be insulated.

6.6 MAIN EARTH

The contractor is to install the M.E.N. main earth electrode, connection and cabling in accordance with AS/NZS 3000:2018 and or subsequently revised editions and the WA Electrical Requirements. If required minimum resistance to earth is not achieved, provide additional length to earth electrode. The main earth connection shall be made below ground level. Install a pit similar to a FCI Products FC4 earth pit to enclose the main connection and electrodes.

Total number of earth rods shall be installed to achieve minimum allowable resistance to earth;

Provide permanent marking on the pit cover to read "Main Earth";

Make connections with approved copper or brass band type clamps. Ensure that clamping bolts are securely fixed complete with label engraved with 5mm red filled lettering in upper case to read:

MAIN EARTH - DO NOT DISCONNECT; and enclose main earth cable from earth position to main switchboard in H.D. plastic conduit.

6.7 POWER SUPPLY AND LIAISON WITH SUPPLY AUTHORITY

The Contractor shall allow for carrying out all liaisons with the Supply Authority and the University of CU. This shall include obtaining all Supply Authority approvals as required and arranging for Western Power connections at pillar unit.

Complete and submit all notices as required by Western Power and the University of CU.

Should a Western Power pillar exist the Contractor shall allow for connection over a distance of no more than ten metres from the irrigation control cabinet.

Should a Western Power pillar not exist the Contractor shall allow for all applications required by Western Power to have a pillar installed at a location approved by the University.

6.8 CONDUITS AND CABLE PITS

Generally, Class B rigid PVC conduits shall be used except where exposed to mechanical damage or sunlight where galvanised screwed steel conduits or G.W.P. shall be used.

The minimum size conduits shall be 50mm diameter, except where the conduit size is specified. If corrugated conduits are being used, select the size to give an equivalent internal diameter.

Unless otherwise specified, all joints in PVC conduit shall be welded.

One makes of conduit, fittings and welding solution shall be used throughout.

Couplings on conduits shall be lock nutted. Conduit ends shall be bushed throughout. Make joints between conduits and between conduits and accessories solid and waterproof.

Conduit boxes shall be proprietary units with conduit access facilities.

The ends of conduits shall be internally reamed clear of sharp edges and projections.

Install electrical conduits 600mm below finished ground level and in accordance with the manufacturer's preferred recommended practice.

Excavate trenches straight and true and to an adequate depth to provide the required cover for conduits. Ensure that the bottom of trenches are flat and clear of protrusions such as rocks, tree roots and the like, prior to installation of conduits.

Arrange conduits so that the maker identification and the conduit category are uppermost in clear view.

Whether containing cables or not, underground conduits shall be provided with a 7/0.67 (2.5 sq.mm) PVC covered draw wire.

Cover conduits with 150mm depth of rubble free sand and place an identification tape, 150mm above the conduit along the entire length of the installation. Use orange plastic tape, approximately 150mm wide and indelibly marked "DANGER ELECTRIC CABLE BELOW", at not more than 1 metre intervals.

Complete backfilling of trenches using clean fill and compact to match surrounding material.

Backfilling and tamping of trenches where passing under footpaths, car parks and other load bearing areas shall be carried out in layers, 200mm maximum thickness.

Electrical services cable pits are not to be installed unless prior approval has been granted by the University of CU. Should approval be granted for the installation of cable pits, they are to be installed in accordance with manufacturer's preferred recommended practice.

6.9 IRRIGATION CONTROL CABINET

The Contractor shall fabricate and install one free standing aluminium enclosure cabinet. This cabinet shall be of sufficient size to house the required electrical controls and monitoring equipment, digital flow meter readout, including the VFD, sine wave filters, and associated components, and the Irrigation Controller.

Refer to the relevant standard drawing for the cubicle layout and components.

The new electrical cubicle shall be installed as close as is practical (allowing for future maintenance) to the Bore hole.

If more than one pump is required for an installation, where practical, one cabinet shall be used to house the controls and switchgear for all pumps.

The Contractor shall fabricate and install a free-standing aluminium enclosure as per attached drawings. The cabinet shall be constructed of quality aluminium alloy (grade 5005/H34). All seams shall be welded and ground smooth.

The cabinet shall be powdered coated Basalt matt finish (code 2607475).

The door shall have block type lift-off hinges of chrome plated brass with stainless steel pins and chrome plated handles. All doors shall be fitted with gas struts to limit door swing. Chains are not acceptable.

The doors are to be fitted with swing pad lockable handles and locking bars.

The cabinet is to be adequately ventilated for the site conditions and particular attention is to be given to ventilation cooling fans for the electrical compartment, if required.

The entire cabinet shall be sealed by appropriate methods to prevent entry of sand, dust, insects and water moisture.

The cabinet shall have a sealed aluminium floor plate.

Attention shall be given to designing the cabinet to prevent condensation occurring.

All bolts, nuts, handles and fittings, etc. exposed to view shall be chromium plated and polished. All other screws, nuts, etc. shall be stainless steel. Visible nuts shall be 'acorn' or 'knurled knob' type.

Escutcheon plates shall be secured with knurled chrome plated thumb screws. Self-tapping or tek screws are not acceptable.

Where required, attachments shall be machine tapped thread with fitting screws and locking washers.

Bolt sizes 6mm and above shall be attached using nutserts or equivalent in zinc or cad plating.

The cabinet shall be fitted with engraved labels on the front doors or panels indicating switch board designation.

Labelling shall be engraved on Gravo-Ply material or similar, and shall use black lettering on white background, except for warning labels which shall display white letters on a red background.

Control panels accessed by a maintenance staff shall be dead front construction with all equipment either flush mounted in escutcheon panels or on recessed panels behind hinged doors.

All control cables shall have CRITCHEY Z TYPE cable markers and be terminated using bootlace pins. The control cables numbers must correspond exactly with the numbers as shown on the 'as constructed' wiring diagrams.

All incoming and continuation of cables and wires shall be clearly labelled with the service they supply and end of run e.g. "Electrical Feed to PC", "Irrigation Control Cable 1" and "Pump Start".

6.10 CONCRETE BASE AND CONDUIT ENTRY

The cabinet shall be mounted on a new suitable concrete base which shall have a void cast through the centre area, for entry of wiring conduit.

The open end of the conduit within the cabinet shall be sealed with a silastic sealant to prevent condensation entering the cabinet interior.

6.11 CIRCUIT DIAGRAMS

The Contractor shall provide 'As Installed' circuit diagrams showing wire numbers, rating and operation settings for all electrical circuits. Diagrams shall be provided as an electronic file and paper copies on a minimum size of A3 drawing sheets. The drawings shall provide all information necessary for the operation, maintenance and replacement of equipment.

One copy shall be laminated in clear plastic and stored in the cabinet.

Copyright of the circuitry drawings becomes the property of the Principal.

6.12 PUMP PROTECTION

The pump protection equipment and settings installed by the Contractor shall ensure failsafe operation of the pumping equipment when operating in each of manual or automatic mode.

6.12.1 HIGH/LOW PRESSURE AND FLOW PROTECTION

The Contractor shall include for the supply and installation of high and low pressure switches complete with time delays and fault lights. The setting of each pressure switch

and time delay shall be carried out on site by the Contractor, to ensure satisfactory system operation.

High & low pressure settings shall be within the operating range of the pump installed.

Two suitable 80mm pressure gauges with a 0 - 1000 kPa range shall be installed within the cabinet and connected into the pressure line. One to show the system pressure and one to show the mainline pressure. The gauges shall be marked with a label as "Mainline" and "System".

The pressure gauges shall be mounted in a way which ensures they are easily read by the system operator.

Flow fault detection (no flow) shall be provided where nominated for each site and shall be signalled by a limit switch mounted on a check valve with spindle, or by a paddle switch unless otherwise specified. The Contractor shall ensure that the pump discharge fittings are configured to accommodate the flow switch arrangement.

The system shall be wired to provide fault shut-down for low flow and activate a fault lamp.

6.12.2 NO FLOW PROTECTION

Flow fault detection (no flow) shall be provided. Where an electromagnetic flowmeter is in use the low flow signal should be used to enable this protection. The system shall be wired to provide fault shut-down for low flow and activate a fault indication.

6.12.3 BORE LOW LEVEL PROBE

The Contractor shall supply and install a two wire low level bore probe within the 25mm probe conduit. A probe relay, fault light and lock out relay shall be installed by the Contractor.

6.12.4 MAXIMUM STARTS

When switch selector in "Auto" position the maximum allowed pump starts shall be limited no more than 10 per hour.

6.12.5 MOTOR OVERLOAD PROTECTION

The VFD has electronic overload protection that will operate should a pump overload occur. The "PUMP START FAULT" lamp will illuminate and the pump starter will be shutdown.

6.13 MOTOR STARTER AND CONTROLS

The Contractor shall include all necessary motor protection equipment and switch gear as specified by the motor manufacturer, although it may not be individually stated in this specification.

The Contractor shall size electrical circuitry to be a minimum of one size larger than the motor size required to be operated from the cabinet.

For motors up to 2.2kW the motor starters shall be approved D.O.L. type.

For motors exceeding 2.2kW the motor starters shall be approved Danfoss or Vacon 100 Flow VFD with sine wave filters.

The units supplied shall be suitable for operating satisfactorily under the site conditions that will prevail.

The starter shall be fitted with by-pass contactors and thermal overload protection with manual reset locks.

The Contractor shall adjust the starting and stopping parameters of the units to suit the operating conditions of the motor.

Full details of the equipment offered are to be submitted with the tender.

The pump starter shall be wired to start/stop the bore pump when a signal is supplied by:-

- An automatic signal from the irrigation controller where the bore pump or irrigation pump is discharging directly into the irrigation system.
- An automatic signal from the tank level probes where the bore pump is discharging into a storage tank.
- Manual push button switches.
- Any of the pump safety devices.

6.14 PUMP CONTROL FEATURES AND BUILT IN PROTECTIONS

All pump functions are to be controlled by an IMO iSMART PLC connected to an iVIEW HMI 7" M series touch screen.

All indications are to be clearly shown on the screen and access to different modes of operation and settings shall be protected by a password in order to prevent unauthorised changes.

All settings such as high and low pressure and by pass timers shall be able to be accessed and modified via the touch screen HMI without the need for a laptop.

The touch screen HMI shall be programmed such that the following functions can be obtained:

- Auto position: Automatically start/stop with a signal from the irrigation controller, water level control probes or similar remote signal.
- Off position: All controls are isolated and the pump cannot be started
- Manual position: The pump is to be started by simulated push button on the touch panel independent of the irrigation controller with all protections in place.
- Service mode position: Access to this mode shall be protected by a password. The pump can be started with all protections disabled except for integral protections such as overload, short circuit and earth failure.
- Pump status and process status indication
- Pump running indication
- Pump speed indication
- Pump current draw indication

- Pump fault and fault description for each type of fault
- Simulated reset button to reset all faults
- Phase failure protection c/w indication and reset
- Low bore level protection complete with relay and 316 SS probes
- Low pressure protection with adjustable pressure value, bypass timer and fault indication
- High pressure protection with adjustable pressure value, by-pass timer and fault indication
- No flow protection with adjustable bypass timer and fault indication
- Hour meter indicating the usage of the irrigation pump
- Number of starts counter
- Fault log with real time stamp and indication of the last recorded fault
- Pressure transducer and digital display of the pressure in the system
- Signals to remote devices for fault and pump running
- VACON FLOW 100 variable speed drive
- LC SINE FILTER

6.14.1 PUSH TO TEST FAULT INDICATORS

All indicator lights shall be the "Push to Test" type which allows to be tested by pressing the relevant indicator light.

6.14.2 RESETTING OF PUMP FAULTS

A pump fault RESET button shall be included to clear and reset electrical pump faults.

6.14.3 SELECTOR SWITCH

In addition to the main isolating switch an Auto-Off-Manual key operated switch is to be installed. The selector switch shall be wired such that the following function can be obtained:

Auto position: Automatically start/stop with a signal from the irrigation controller, water level control probes or similar remote signal. With all protections in operation.

Off position: All controls are isolated, and key is removable.

Manual position: The pump is to be started by push button on/off switches, independent of the irrigation controller and by passing flow safety shut down switches only.

6.15 ANCILLARY EQUIPMENT

A suitable ammeter (70mm x 70mm face) shall be installed by the Contractor. The maximum full load running current of the motor shall be indicated with a red line.

A manually operated reset button shall be installed to clear all faults. An hour run meter shall be installed for each pump.

All fuses for electrical controls shall be HRC type.

Separate fault defect lamps (coloured red) shall be installed for each of the following faults for each pump: low level, starter, overload, high and low pressure faults, and any other faults monitored.

A pump run lamp (coloured green) shall be installed and be functional in both the automatic and manual mode of operation. A 15 AMP 1 phase power outlet shall be installed within the control enclosure with all new cabinets and power supply. Where an existing power supply is being utilised, which does not permit the installation of a power outlet the outlet shall be omitted.

6.15.1 WESTERN POWER KILOWATT HOUR METER

Where required supply and install a Western Power approved Kilowatt hour meter for the monitoring of the power consumption. Meters may be obtained from a Western Power outlet.

6.15.2 FUTURE FLOOD LIGHTS

If required install 24-volt relays fed from the last stations on the irrigation controller. Mount and mark clearly on the cabinet next to the relays.

6.15.3 LABELLING

All equipment within the cabinet shall be clearly marked with precise and easy to read Gravo Plate engraved labels.

The Contractor shall supply a warning notice in a conspicuous position in the cabinet. The notice shall read as follows:

"WARNING: LOCK SWITCH IN OFF POSITION AND REMOVE KEY WHEN WORKING ON MOTOR"

6.15.4 FLOW METER READOUT

Where required as detailed in the project specification for each site, a remote digital read-out will be installed in the cabinet to display the required flow measurement.

6.16 CABLING

The electrical Contractor shall size, supply and install all necessary electrical cables between the pump control cabinet and the bore discharge junction box.

Cables shall be T.P.S and be of copper unless otherwise specified.

All cabling shall be installed in adequately sized conduits and in accordance with electrical regulations.

7 GROUNDWATER BORES

7.1 LICENCE TO CONSTRUCT AND EXTRACT

The Contractor shall:

- Allow for making all applications for the construction of a new Groundwater bore with the Department of Water.
- Abide by the standard terms, limitations and conditions noted on the Well (Bore) Construction Licence once issued.
- Complete and return all additional forms required by the Department of Water on completion of construction of the new bore.

New bore locations must be approved and verified with the University.

The University expects that all bores within their shire boundaries shall be metered and hold their own extraction license. There shall be no more than a single bore constructed per reserve, park or irrigated area and/or sharing of extraction licenses over multiple bores will not be permitted unless written permission is granted from the University's Irrigation Technical Officer.

7.2 DRILLERS LICENCE

The driller shall hold an appropriate, valid Driller's Licence as issued by the Australian Drilling Industry Association Ltd applicable to the type of bore, aquifer to be accessed and construction methods expected during construction of the new bore. Drillers Licence class and number shall be submitted to the University prior to the commencement of bore construction.

7.3 MCRWBA

The works shall be undertaken in accordance with the Minimum Construction Requirements for Water Bores in Australia (MCRWBA), standard drilling industry practice, Department of Water requirements and Department of Environment guidelines.

7.4 DRILLING METHOD

Bores shall be constructed using either cable tool or mud rotary drilling as required. The driller shall collect drill cuttings at 1.0 metre intervals, or upon changes in the formation. Samples should be used to develop a documented profile of the soil strata levels.

NOTE: If any samples of strata or water give rise for concern during the drilling process, the Contractor must contact the Superintendent before installing any equipment in the bore.

7.5 VERTICALITY AND ALIGNMENT

The bore shall be drilled and cased straight and vertical and all casings shall be set round, plumb and true to line. The maximum out of vertical tolerance allowable shall be 100mm per 30 metres of depth.

The Contractor shall supply all equipment necessary to test the cased bore for verticality and alignment, and shall, on request, carry out such tests to the satisfaction of the University's representative.

Should the Contractor fail to correct a faulty alignment, the University may refuse to accept the bore. Any delays encountered in any such correction shall be at the Contractor's expense.

7.6 GRAVEL PACKING

The annulus surrounding the casing and screen shall be packed with 50mm of suitably sized washed and graded sand from the static water level to the base of the bore hole. The annulus surrounding the casing shall be backfilled with drill cuttings from the surface to the static water level.

7.7 CASING

Bores shall be constructed using a minimum standard of 200mm Class 12 PVC pipe manufactured to AS1477 and utilizing the solvent weld method of jointing (SWJ).

Where production rates under 2.5L/s are required, or requested, a smaller 150mm Class 12 PVC casing size may be considered for approval.

Where an artesian bore is being constructed to a depth of 120 metres or deeper casing should be constructed of Permaglass.

Steel casing shall not be used.

7.8 SCREEN

The bore screen assembly shall consist of an IN-LINE type Grade 304 stainless steel, wedge wire screen with a diameter to suit the bore casing and an aperture of 0.5mm or finer if required by silt testing.

NOTE: Slotted PVC screens are not acceptable under any circumstances.

7.9 DEVELOPMENT

On completion of construction, the bore shall be developed (minimum 8hrs) to a maximum yield of water, clean and free of suspended materials.

Development of the bore shall be carried out by high pressure water jetting, air surging and backwashing. Airlift pumping, chemical treatment using mud dispersants and breakdown agents, or such other standards techniques as may be directed by the University.

Appropriate pipe fixtures and flexible discharge lines shall be required to direct airlift discharge away from the rig and personnel as well as to avoid nuisance at the bore site.

The discharge point is to be established in consultation with the Superintendent prior to commencing development. Any residue or staining shall be removed by the Contractor to the Principal's satisfaction and shall be done at the Contractors cost.

7.10 TEST PUMPING

Test Pumping shall occur upon completion of bore development and shall consist of a three steps in flow rate x one (1) hour step test.

A further 8 hours continuous water supply test using dedicated testing equipment will be performed.

Test equipment must have capacity to pump at a rate equal to 150 % of irrigation design requirements.

Throughout the test a log containing the following data shall be maintained:

1. Reserve Name & Location.
2. Bore Licence Number.
3. Drillers Name.
4. Date of Test.
5. Bore casing diameter material.
6. Diameter, mesh size, length and material of screen.
7. Depth of bore to top of screen.
8. Static Water Level prior to test.
9. Pumping rate of water supply test.
10. Drawdown from Static water Level at nominated continuous test rate.
11. Depth to pump inlet.
12. Water Level and flow rate readings during constant rate test as follows:
 - 0 to 15 minutes - every minute.
 - 15 to 60 minutes - every 5 minutes.
 - 60 to 120 minutes - every 15 minutes.
 - 120 to 600 minutes - every 30 minutes.
 - 600 minutes - every 60 minutes.

Results of these tests shall be forwarded to the University of CU and the Department of Water upon practical completion of bore construction.

7.11 WATER ANALYSIS

An air free water sample is to be taken at the completion of the water supply test for analysis (within 24 hours) by a recognised laboratory capable of performing relevant tests. Analysis shall include a complete report on the quality and suitability of the water for irrigation purposes and include the following information:

- pH
- Conductivity (preferably compensated to 25°; report value measured; compensation factor and complete units (e.g. mS/cm, not mS)
- Total dissolved solids (calculated @ 180°C)

- Total hardness (as CaCO₃)

(Elements below to be expressed as mg/L)

- Calcium Ca
- Magnesium Mg
- Sodium Na
- Potassium K
- Ammonia NH₃
- Phosphate PO₄
- Carbonate CO₃
- Bicarbonate HCO₃
- Chloride Cl
- Sulphate SO₄
- Nitrate NO₃
- Nitrite NO₂
- Silica SiO₂
- Iron Fe²⁺
- Zinc Zn

All reports shall be presented to the Superintendent immediately upon receipt.

NOTE: If any samples of strata or water give rise for concern during the drilling process, the Contractor must contact the Superintendent before installing any equipment in the bore.

7.12 CONSTRUCTION VERIFICATION

The Contractor shall allow on completion of bore development and test pumping operations to have the borehole inspected by C.C.T.V. to verify construction. The footage shall be unbroken and show the bores construction at 100mm intervals. The first frames of footage shall show a white board detailing the Date, Location, Contractor, and Bore Construction Details.

7.13 CASING TERMINATION

On completion of bore development and test pumping operations, the bore casing shall be cut to 400mm above finished ground level and fitted with a galvanised steel, drilled Table E flange and a blank galvanised steel top flange with rubber gasket, to prevent unauthorised access to the bore. The bore casing shall be fitted with a casing clamp 200 mm to 300 mm below the flange.

8 IRRIGATION PUMP

The University have a requirement that every pump that is installed new or following servicing shall be photographed at the borehole prior to installation with a whiteboard showing the Date, Location, Contractor, along with the make, model and serial number of both the pump and motor. With the photograph submitted to the University for record keeping.

8.1 CONSTRUCTION MATERIALS

The preferred pump shall be of Grundfos manufacture and shall be zinc free bronze metal or stainless steel in construction.

Alternative offers for pump make or construction shall be at the approval of the University's Irrigation Technical Officer.

8.2 SUBMERSIBLE MOTOR

The submersible motor shall be 415 volt 50 cycle, capable of operating continuously at a power suitable for the peak of the pump power characteristics.

The motor shall be fitted with non-corrosive end bells. Ni resist metal would be acceptable.

8.3 MOTOR LEAD / DROP CABLE

Hydrofirm, Eucahydro or Aflex EPR/PUR cable, sized appropriately for the power requirements of the motor and terminating in the bore head metal junction box. The bore pump shall have a 2 metre surplus loop neatly strapped to the pump column.

8.4 SAFTEY CABLE

The Contractor shall install two (2) appropriately sized stainless steel safety cables attached to the pump outlet and secured to the bore cover plate.

8.5 DISCHARGE COLUMN

For submersible pumps, the discharge column shall consist of Class 18 PVC or Permaglass pump column with stainless steel couplings.

Column centralisers shall be installed at the pump and at a minimum of 12 metre intervals of columns to protect electrical cables.

All conduits and cables shall be installed and clipped to the column at regular intervals. Allowances shall be made for any likely expansion or twisting of the pump column.

8.6 BORE WATER LEVEL MEASUREMENT

8.6.1 WATER LEVEL PROBE TUBE

A continuous probe conduit of either 20mm PE or 25mm PVC shall be installed, terminating level with the top of the pump(s) to enable water level measurement using an electrical probe.

The bottom of the conduit shall be capped and water inlet holes drilled along the bottom 1.0 metre of pipe. Bottom of the probe conduit shall be set at the top of the submersible pump.

Access to the probe conduit shall be through one of the junction boxes located on the discharge plate, and in a separate junction box to the motor lead / drop cable connection.

The probe conduit shall be installed in such a way as to ensure that the two wire probe can be moved freely within the conduit for adjustment.

8.6.2 DRAW DOWN TUBE

The Contractor shall allow for and install a nylon airline tube down the bore terminated in a Schrader valve at the base plate at the top of the bore. The length of pipe installed shall be accurately measured and information supplied to the Superintendent.

8.7 CONCRETE BORE PLINTH

Groundwater bores shall require a flat and level accessible hardstand. The size and location shall provide for sufficient maintenance access and will require approval from the University.

The Contractor shall allow for all necessary form work, concrete and site labour to construct concrete plinth of sufficient size to allow for installation of all down hole and discharge components.

Concrete plinths shall be of at least 20 MPa at 28 day strength, free of surface defects or honeycombing.

8.7.1 BORE DISCHARGE ASSEMBLY

All bore discharge assemblies are to be approved by University of CU with fittings to conduct production testing.

The Contractor shall supply and install the bore discharge head assembly and discharge pipework and fittings including all gaskets, nuts and bolts and valves.

Discharge pipework and fittings shall be flanged galvanised steel sized as detailed on the relevant drawing, ending 450mm below ground level to connect to the irrigation system mainline.

All flanges shall be a minimum of PN14 to AS 4087-2004.

8.7.2 PUMP PERFORMANCE TEST

On completion of the pump installation the Contractor shall perform a pump performance test and submit the results to the Superintendent. The following minimum information is required:

- Clear bore location/name/pump description.
- Casing diameter and material if known.
- Discharge fittings and material: Schematic sketch showing layout/arrangement, size and condition of components.
- All pump detail available: e.g. Make, size, model.
- Pump electrical control information available: e.g. VFD/Star Delta/DOL/ Soft Starter.
- SWL to be recorded before test.
- Flow/pressure test to be performed starting from closed discharge valve pressure in 100kPa decreasing increments to fully open discharge valve position.
- Pressure at GL and Flow rate recorded for each step.
- DWL/Draw down to be recorded for each step.
- Each step to run for 4 minutes before WL and flow rate readings.
- Results to be tabulated and submitted to Superintendent.
- Method of flow measurement to be noted.
- Existing flow meter information/make /model/serial number if available.
- Existing flow meter readings compared with test flow meter readings (suggested at three different flow rates).
- Low water level probe depth/set point.
- Any concerns or suggestions on installation.

8.8 "AS CONSTRUCTED" RECORDS

AutoCAD files must be submitted to the University prior to any Practical Completion or Handover meetings with the University. Open space O-Spec data must be submitted within 3 weeks of practical completion.

8.8.1 DRAWINGS

At Practical Completion of the complete installation, the Contractor shall be responsible for having installed components professionally surveyed and survey data prepared and supplied to the University in accordance to O-Spec digital data specification requirements.

AutoCAD prepared drawings shall be supplied to the University in two electronic copies (AutoCAD and PDF) and one hard copy, electronic drawing files to be compatible with AutoCAD version 2010, accurately showing all "as constructed" details.

Where applicable the University may provide an electronic copy of the "as designed" drawings to the Contractors employed by the University for the purpose of updating to "as constructed". At the discretion of the University, a company may be excluded from carrying out any future work for the University should it fail to submit as constructed drawings in the agreed time.

"As constructed" drawings shall be prepared in accordance with the University of CU's CAD standards. The University's Irrigation Technical Officer may be contacted to obtain confirmation of drawing number, standard drawing template and a copy of current CAD standards.

8.8.2 GPS BASED

Prior to PC.

The intent of As Constructed drawings is to allow for future location of components. Therefore in order to verify the AS Constructed drawings for suitability it will be required the Contractor shall provide a complete printed set of draft 'As Constructed' documents to the Superintendent covering all in ground and above ground services, components and infrastructure installed or modified during the works.

The 'As Constructed' set shall include all information related to work and components as outlined in this specification.

The drawings shall show accurate locations of sizes of pipework, road crossings, valves, sprinklers, cables, controllers, main connections and other components relevant to the irrigation system.

8.8.3 DRAWING SURVEY DATUM

The Contractor shall provide or employ a suitable provider of surveying services to carry out GPS surveying of irrigation components for incorporation in the "As Constructed" documents as follows:

- A. A full survey of the applicable irrigation components listed below in points 1 – 11. The survey shall be less than or equal to 10cm X/Y accuracy.
- B. Survey shall focus on the location and depth of all major irrigation components in-ground services listed and be done prior to backfilling including invert levels to mainline pipework, shown to scale and located via established geo-referenced co-ordinates in PCG-94 format. The Contractor shall ensure that no part of the work is backfilled or otherwise covered up until "As Constructed" information has been obtained to the satisfaction of the Superintendent.

Should the survey be done after completion of the works (or part of the works) all services shall be clearly marked with vertical conduit written up with the depth and description of the components for the surveyor/operator use and notation on the drawings.

8.8.4 TRIANGULATED MEASUREMENTS

Where accurate GPS surveying is not achievable due to site specific restraints, the Contractor shall carry out triangulated measurements from points that are geo-referenced (GPS'd) or alternatively from fixed reference points to in-ground irrigation components, listed below in points 1 – 11, for incorporation in the "As Constructed" documents. The Contractor shall ensure that no part of the work is backfilled or otherwise covered up until "As Constructed" information has been obtained to the satisfaction of the Superintendent.

Should the survey be done after completion of the works (or part of the works) all services shall be clearly marked with vertical conduit written up with the depth and description of the components for the surveyor/operator use and notation on the drawings.

8.8.5 INFORMATION TO BE SHOWN ON AS CON DRAWINGS

AsConstructed drawings shall include all existing work encountered, new work installed and amendments made to the existing irrigation system and show the integration between existing and new work.

The intent of the 'As Constructed' drawing is that it will be an accurate reflection of the installed system, which can be utilised by the system operator to locate and identify components for future maintenance and servicing, providing the necessary technical and positioning information to assist with system scheduling and balancing the operation of system solenoid valves. The following shall be provided as a minimum level of information: (Where applicable.)

- Pump location.
- Electrical pump controls location including irrigation controller.
- Any run of irrigation control conduit/wires not in same alignment of mainline pipework.
- New mainline/sub main starting, finishing points, size and type of mainline pipe used (i.e. uPVC/HDPE).
- Changes in direction of mainline, sub-main.
- Any existing services (with description) encountered during excavation.
- Location of spare solenoid wires in the field.
- Road crossings and sleeves, size and type of sleeves
- Solenoid valve locations.
- Cable pit locations.
- Isolation valve locations.
- Each and every mainline and lateral T joint, bend and valve.
- As constructed valve table-showing details for each valve or other decoder activated component and including decoder address for each decoder.
- A table showing each sensor decoder and condition monitored and any simultaneous station groupings.
- All existing features to be in grey pen or lighter line weight.
- As Constructed data to be surveyed by a licenced surveyor.
- The following information is to be shown in representative location – does not require GPS survey but is required to give a clear representation of the installed system:
 - Location, make and models of sprinklers & sprays & bubblers.
 - New lateral pipework starting, finishing points, size and type of pipe used (i.e. uPVC/HDPE).

8.8.6 NOTES

To assist with accuracy, the Contractor shall mark up the construction drawings after each day's work to reflect the position of equipment installed that day.

Solenoid wire colour or wire code numbers for each valve shall be shown in the valve table on the drawing.

Where practical, the system operating pressure, as measured at the point of connection to the water supply shall be recorded for each station and shown on the 'As Constructed' drawing Station Data table.

Where the extent of drip areas or configurations have changed during construction, the revised valve flows will be calculated by the Contractor and will be shown on the 'As Constructed' drawing.

The location of the controller, total station capacity of the controller installed or connected to, the number of stations used and the quantity of spare wires available shall be clearly identified on the 'As Constructed' drawing.

The form of presentation shall be acceptable to the Superintendent. As a minimum requirement, the symbols used shall be the same as those used on the drawing approved for construction.

All measurements shall be in metres to the first decimal point.

The drawings shall show, at least the same level of site details as the drawings issued for construction.

Where landscape features (e.g. pathways, garden beds) have changed from those shown on the construction drawing, the Contractor shall indicate the extent and alignment of such changes on the drawing with a notation such as "path location shown not accurate/changed/new".

The survey layout shall be drawn on a separate layer to the construction layer which shall not be deleted. (Call the layer 'SURVEY' and this layer shall be 'frozen').

The original construction drawing layers shall be 'frozen' and the 'As Constructed' drawing detail shall be on separate layers.

During construction the Contractor shall keep accurate records of all drawings amendments. Make any adjustments required to "As Constructed" documentation of the works and establish a system for ongoing maintenance of the "As Constructed" record. The Contractor shall prepare and submit "As Constructed" drawings for all Irrigation and Electrical contract drawings. Sub-Contractors for specialist services shall comply with the requirements for "As Constructed" drawings and operating instructions of these preliminaries.

All "As Constructed" drawings should be submitted to the relevant Consultants for comments and approval. Submit approved "As Constructed" drawings to Superintendent.

8.8.7 AS CONSTRUCTED DOCUMENTATION - ALTERNATIVE - TRIANGULAR DIMENSIONING

Prior to PC.

The intent of As Constructed drawings is to allow for future location of components. Therefore in order to verify the AS Constructed drawings for suitability it will be required the Contractor shall provide a complete printed set of draft 'As Constructed' documents

to the Superintendent covering all in ground and above ground services, components and infrastructure installed or modified during the works.

The 'As Constructed' set shall include all information related to work and components as outlined in this specification.

The drawings shall show accurate locations of sizes of pipework, road crossings, valves, sprinklers, cables, controllers, main connections and other components relevant to the irrigation system.

The Contractor shall supply accurately surveyed 'As Constructed' drawings of the new works at the site.

The Contractor shall carry out triangulated measurements from fixed reference points to in-ground irrigation components, listed below in points 1 – 11, for incorporation in the "As Constructed" documents. The Contractor shall ensure that no part of the work is backfilled or otherwise covered up until "As Constructed" information has been obtained to the satisfaction of the Superintendent.

Should the survey be done after completion of the works (or part of the works) all services shall be clearly marked with vertical conduit written up with the depth and description of the components for the surveyor/operator use and notation on the drawings.

The Contractors shall submit a draft paper copy of the 'As Constructed' drawing for approval of the Superintendent, at the time of Practical Completion. Final copies of the required formats shall not be provided by the Contractor until approval of the draft has been given by the Superintendent.

The intent of the 'As Constructed' drawing is that it will be an accurate reflection of the system installation which can be utilised by the system operator to locate and identify components for servicing and provide the necessary information to assist with system scheduling and balanced operation of system solenoid valves.

The following shall be provided as a minimum level of information:

- Pump location.
- Electrical pump controls location including irrigation controller.
- Any run of irrigation control conduit/wires not in same alignment of mainline pipework.
- New mainline/sub main starting, finishing points, size and type of mainline pipe used (i.e. uPVC/HDPE).
- Changes in direction of mainline, sub-main.
- Any existing services (with description) encountered during excavation.
- Location of spare solenoid wires in the field.
- Road crossings and sleeves, size and type of sleeves
- Solenoid valve locations.
- Cable pit locations.
- Isolation valve locations.
- Each and every mainline and lateral T joint, bend and valve.
- As constructed valve table-showing details for each valve or other decoder activated component and including decoder address for each decoder.

- A table showing each sensor decoder and condition monitored and any simultaneous station groupings.
- All existing features to be in grey pen or lighter line weight.
- As Constructed data to be surveyed by a licenced surveyor.
- The following information is to be shown in representative location – does not require GPS survey but is required to give a clear representation of the installed system:
 - Location, make and models of sprinklers & sprays & bubblers.
 - New lateral pipework starting, finishing points, size and type of pipe used (i.e. uPVC/HDPE).

The drawings shall show accurate locations of sizes of pipework, road crossings, valves, sprinklers, cables, controllers, main connections and other components relevant to the irrigation system, with triangulated measurements from fixed reference points to each location shown.

To assist with accuracy, the Contractor shall mark up the construction drawings after each day's work to reflect the position of equipment installed that day.

Solenoid wire colour or wire code numbers for each valve shall be shown in the valve table on the drawing.

The system operating pressure, as measured at the pump discharge pipework assembly shall be recorded for each station and shown on the 'As Constructed' drawing valve table.

Where sprinkler head numbers or configurations have changed during construction, the revised valve flows will be calculated by the Contractor and will be shown on the 'As Constructed' drawing.

The form of presentation shall be acceptable to the Superintendent. As a minimum requirement, the symbols used shall be the same as those used on the drawing approved for construction.

All measurements shall be in metres to the first decimal point.

The drawings shall show, at least the same level of site details as the drawings issued for construction.

Where landscape features (e.g. pathways, garden beds) have changed from those shown on the construction drawing, the Contractor shall indicate these changes on the drawing with a notation such as "path location shown not accurate".

The survey layout shall be drawn on a separate layer to the construction layer which shall not be deleted. (Call the layer 'SURVEY' and this layer shall be 'frozen').

The original construction drawing layers shall be 'frozen' and the 'as constructed' drawing detail shall be on separate layers.

8.8.8 NOTES

To assist with accuracy, the Contractor shall mark up the construction drawings after each day's work to reflect the position of equipment installed that day.

Solenoid wire colour or wire code numbers for each valve shall be shown in the valve table on the drawing.

Where practical, the system operating pressure, as measured at the point of connection to the water supply shall be recorded for each station and shown on the 'As Constructed' drawing Station Data table.

Where the extent of drip areas or configurations have changed during construction, the revised valve flows will be calculated by the Contractor and will be shown on the 'As Constructed' drawing.

The location of the controller, total station capacity of the controller installed or connected to, the number of stations used and the quantity of spare wires available shall be clearly identified on the 'As Constructed' drawing.

The form of presentation shall be acceptable to the Superintendent. As a minimum requirement, the symbols used shall be the same as those used on the drawing approved for construction.

All measurements shall be in metres to the first decimal point.

The drawings shall show, at least the same level of site details as the drawings issued for construction.

Where landscape features (e.g. pathways, garden beds) have changed from those shown on the construction drawing, the Contractor shall indicate the extent and alignment of such changes on the drawing with a notation such as "path location shown not accurate/changed/new".

The survey layout shall be drawn on a separate layer to the construction layer which shall not be deleted. (Call the layer 'SURVEY' and this layer shall be 'frozen').

The original construction drawing layers shall be 'frozen' and the 'As Constructed' drawing detail shall be on separate layers.

During construction the Contractor shall keep accurate records of all drawings amendments. Make any adjustments required to "As Constructed" documentation of the works and establish a system for ongoing maintenance of the "As Constructed" record. The Contractor shall prepare and submit "As Constructed" drawings for all Irrigation and Electrical contract drawings. Sub-Contractors for specialist services shall comply with the requirements for "As Constructed" drawings and operating instructions of these preliminaries.

All "As Constructed" drawings should be submitted to the relevant Consultants for comments and approval. Submit approved "As Constructed" drawings to Superintendent.

8.8.9 "AS CONSTRUCTED" PROCESS AND DETAIL

At Practical Completion and handover, the system shall be put to test under normal automatic operation.

8.8.10 TO BE PROVIDED AT HANDOVER FOR ALL NEW SYSTEMS

For the irrigation and bore/pumping systems, the Contractor shall supply one (1) set of any:

- Technical information, operating and maintenance manuals in A4 "d" ring folders with plastic sheet protectors.
- Irrigation as con plans' one (1) set in hard copy and two (2) in electronic format
- Guarantees and warranties.
- Any special tools, keys etc.
- All software programs for any electrical components such as PLC and VSD's.
- Electrical plans and Certification.
- Confirmation that the irrigation system meets the CU Standard Irrigation Specifications.
- Bore construction and pump details.
- A photograph printed in A4 of pump at the borehole prior to installation with a whiteboard showing the Date, Location, Contractor, along with the make, model and serial number of both the pump and motor.

9 TESTING, COMMISSIONING, AND MAINTENANCE

The Contractor shall undertake all necessary testing, commissioning and maintenance of equipment installed with the irrigation systems. Examination and testing shall be carried out by the Contractor as an integral part of the work under the Contract.

9.1 WARRANTY

The Contractor shall guarantee the system against faulty materials, workmanship and performance for a period of 12 months from the Date of Practical Completion. Contractor shall submit any material warranties given by the manufacturers that exceed 12 months.

9.2 FLUSHING

The pipelines shall be flushed and cleared by the Contractor until they are clean to the satisfaction of the Superintendent. The Contractor at his expense will rectify valve or sprinkler malfunction due to inadequate flushing.

9.3 TESTING

Testing of the system will be carried out in the presence of the Superintendent immediately after flushing procedures are finished and the system is deemed to be operational.

9.3.1 TESTING OF NEW IRRIGATION MAINLINES – PVC CLASS 12/ HDPE PN12.5

The Contractor shall perform a hydrostatic test on completed mainline pipework in accordance with AS/NZS 2566.2:2002 Item 6.3.4.4.

The pressure test shall be performed in the presence of the Superintendent. The Contractor shall give notice to the Superintendent a minimum of two (2) working days prior to the test.

Where concrete thrust blocks were constructed pressure tests must not be performed earlier than 48 hours after pouring thrust blocks.

Pressure tests may be performed on completed sections of mainline pipework.

Pressure gauges with an operating range 0 – 2500kPa shall be used.

In general mainline pipework being tested shall be:

- Isolated at both ends.
- Fitted with a similar pair of pressure gauges at a single test point to monitor the pressure inside the completed pipework.
- Filled with water ensuring that all air is expelled from the completed pipework prior to testing.

- Pressurized to 1200kPa (Class12 or equivalent pressure rated pipe) for the test period of thirty (30) minutes.
- The pressure shown on both gauges shall be recorded at the start of the test and every 10 minutes including at the end of the test period.
- The pressure test shall be deemed successful if:
- There is no failure of any thrust block, pipe, and fitting, joint, or other pipe component.
- The pressure drop is less than 50kPa during the extended test period.

9.3.2 TESTING OF NEW IRRIGATION LATERAL LINES

Lateral pipe work is not required to be pressure tested. Lateral pipework will be evaluated during PC.

Lateral pipe work shall be deemed acceptable and accepted as being installed correctly if:

- There is no failure of any pipe, fitting, joint, or other pipe component.
- There is no visible leakage from fittings and pipe work.

9.3.3 PUMP TESTING

The Contractor shall be required to perform a pump flow/pressure/drawdown performance test on the pumping system on completion of the Works.

The Contractor has to supply a suitable, calibrated flow meter and install in the test tee discharge to compare readings with the existing meter.

The Contractor has to supply a suitable, calibrated pressure gauge and install upstream of control valve to compare readings with the/any existing pressure gauge.

9.3.4 TEST DATA TO BE RECORDED

1. SWL to be recorded prior to commencing production test:
2. Flow/pressure test to be performed from closed discharge valve pressure in -100kPa decreasing increments to fully open discharge valve position:
3. Pressure at GL in kPa and Flow rate in L/s recorded for each step:
4. DWL/Draw down in m to be recorded for each step:

9.4 GENERAL INFORMATION TO BE NOTED WHERE ACCESSABLE/AVAILABLE:

1. Clear bore location/name description
2. Casing diameter and material if known
3. Discharge fittings and material, general condition
4. Pump make and model detail available
5. Pump electrical control information available: e.g. VFD/Star Delta/DOL/ Soft Starter? Size/Amperage rating of control gear.
6. Method of flow measurement to be noted
7. Existing flow meter information/make /model/size/serial number if available

8. Existing flow meter readings compared with test flow meter readings (suggested at three different flow rates)
9. Low level probe depth/set point
10. Signs of iron bacteria? If so severity
11. Any other concerns or suggestions on the installation

9.4.1 EARTH LEAKAGE AND CCTV

The University may elect to carry out a pump motor earth leakage test and C.C.T.V. borehole inspection. This may result in the University requesting remedial works to the borehole or pump servicing prior to handover and at the developers cost.

9.5 SYSTEM RUN

The system shall run for seven days on automatic program prior to hand over.

9.6 FINAL CLEANING UP

The entire site must be left in a clean and tidy condition and any equipment, rubbish, spoil including any surplus material accumulated as a result of installation procedures, shall be removed by the Contractor at his own expense.

An inspection of the condition of the site will be carried out prior to Practical Completion and, should the Contractor's efforts to clean up the site be considered to be unsatisfactory, monies will be withheld until the site is restored to an acceptable standard.

Practical Completion will not be certified until the site is cleaned to the Superintendent's satisfaction.

9.7 PRACTICAL COMPLETION

When required, the University shall be contacted to arrange a Practical Completion inspection. Practical Completion will not be deemed complete until the system is proven to have been installed in accordance with University specifications, be functioning normally, and all "as constructed" drawings and other required deliverables have been presented to the Superintendent prior to the practical completion inspection.

9.8 FINAL INSPECTION AND COMMISSIONING

On completion of all works the University of CU must be contacted to arrange a date for final inspection and commissioning. This process must not proceed without the University, or their appointed representative, being present.

Upon completion of all testing and functioning of the water supply system, the Contractor shall program the system to operate automatically at frequency to be advised by the Superintendent.

9.9 DEFECTS LIABILITY

The Defects Liability Period shall be a period of twelve (12) months from the date of Practical Completion for University commissioned projects or two (2) years for works undertaken as part of a development by others (or until the University takes possession of the irrigation component of the development). During this period the Contractor shall warrant his workmanship and will be liable for rectifications to any faults that arise as a result of the installation of the system and shall make good any faults that arise as a result of faulty materials manufacture.

The Contractor shall allow for returns to site as often as requested by the University during DLP to respond to defects related problems such as:

- Sprinkler head heights.
- Sprinkler arc settings.
- Valve box heights.
- Trench subsidence.

The Contractor shall include an allowance to attend any breakdown calls arising from his liabilities during the Defects Liability Period within 24 hours of notification by the University.

At the end of the defect's liability period, or when directed earlier, the Contractor shall raise sprinklers to the surface level of the turf and/or as specified above garden bed surfaces.

All repairs must be completed promptly. This relates to faulty materials and or workmanship and shall not affect any manufacturer's warranty.