

FORM:



**BROOKSBY DRAINAGE - SAFETY REQUIREMENT
SPECIFICATION**

AUTHOR(S):

ANDRIAN HARSONO

The Pirbright Institute

Brooksby Drainage Safety Requirement Specification (SRS)

| Rev. | Date | Author | Checked by | Approved by |
|---------|-------------|---|---|--|
| 1 | 24-APR-2023 | Andrian Harsono – Functional Safety Manager | Jason Tearle – Biosafety Technical Lead | Andy White – Director of Risk and Assurance |
| | | | | |
| | | | | |
| Signed: | |  |  | |

CHANGE HISTORY

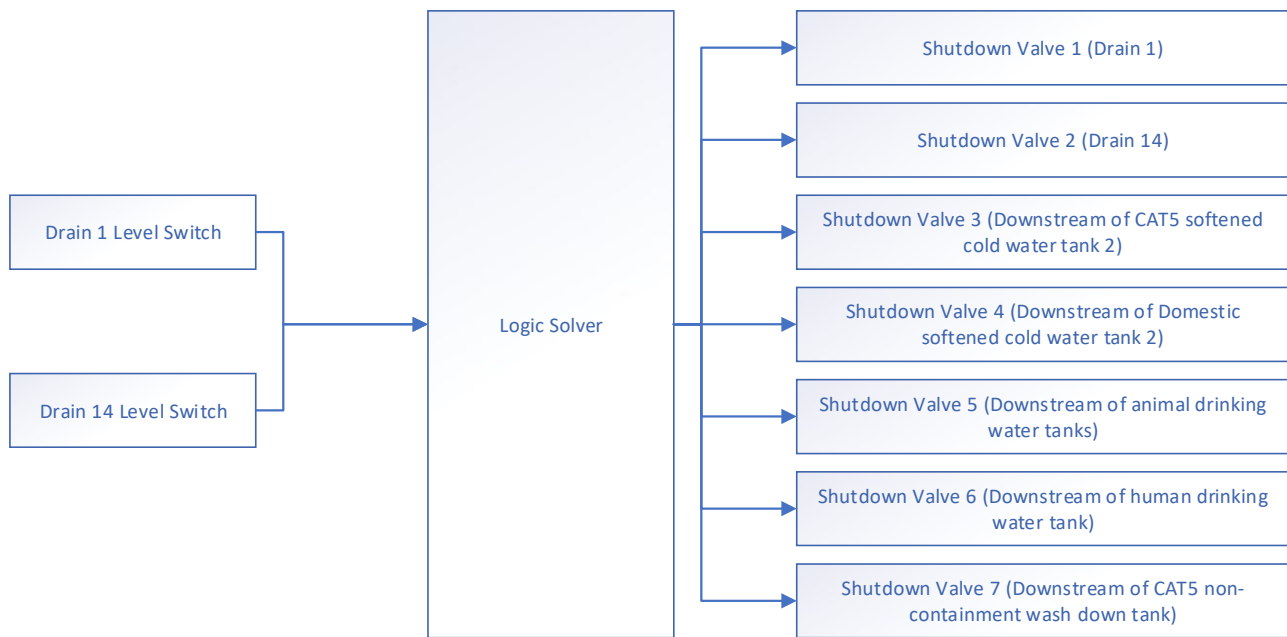
| Revision | Date of Issue | No. of Pages | Reasons for Change |
|----------|---------------|--------------|--|
| 1 | 24-APR-2023 | 5 | SRS ready for Functional Safety Assessment (FSA) Stage 1. Once other pieces of information are confirmed during the design stage (e.g., instrument tag numbers, FAT and SAT procedure numbers), the SRS will be updated again. |

Note: The Safety Requirement Specification (SRS) is one of the most important activities of the functional safety lifecycle. It is through this specification that the user defines how each Safety Instrumented Function (SIF) is to be designed and integrated into the Safety Instrumented System (SIS) and the Building Automated Control System (BACS).

The Functional Safety Manager (FSM) has ownership and responsibility over all SRSs at the Pirbright Institute. As each SRS is developed or modified, it is recommended that it is reviewed by a representative of Health, Safety and Biosafety (e.g., Biosafety Technical Lead) and a representative of Estates Management Services (e.g., Engineering and Operations Manager). All SRSs require approval from the Director of Risk and Assurance.

| Safety Instrumented Function (SIF) Information | |
|--|---|
| Tag | To Be Confirmed (TBC) |
| Process Unit | Brooksby Effluent Treatment Plant |
| Documents | LOPA Report – L140_ST001Rev. 2 P&ID – P800-SUN-98-F0-DR-XX-4002 Water Services Schematic – P800-KME-53-XX-DR-PH-0005 Drainage Schematic (Sheet 1 of 4) – P800-KME-71-XX-DR-PH-0001 Drainage Schematic (Sheet 3 of 4) – P800-KME-71-XX-DR-PH-0003 |
| Safety Function Description | <p>High-High level (fixed point) detection functions are installed at Drains 1 and 14 (Animal Entry room and Barrier Showers respectively); one level switch for each drain. Upon detection of drainage water backing up either of the two drains, the safety function shall:</p> <ul style="list-style-type: none"> • Close two shutdown valves also at Drains 1 and 14 to prevent contaminated water flooding these areas and escaping the building. • Close a further 5 shutdown valves to shut water supply into the building: <ul style="list-style-type: none"> ○ Downstream of CAT5 (softened) cold water system Tank 2 ○ Downstream of Domestic (softened) cold water system Tank 2 ○ Downstream of Animal Drinking Water Tanks ○ Downstream of Human Drinking Water Tank ○ Downstream of CAT5 non-containment wash down tank |
| Hazardous Scenario | <p>Liquid backs up into the drain system to each area of the Brooksby facility due to blockages, leading to significant effluent spilling back out of all ground floor level drains including the cleaning corridor (all drain gulleys on this floor are within 50 mm of each other). Pathogen may cross from one area to another. If the effluent flows out of the secondary containment (e.g., barrier showers, emergency escape routes, animal entry lobby), release of SAPO4 agents to the environment. There is also potential for effluent backed up to spill into the general sewer drains. Note: The effluent spilling out of the low point could be from any of the drain systems connected to the common header including rooms on the main facility floor and the ETP change pump in the basement.</p> |

SIF Logic/Architecture (Part 1)



SIF Components

Tags TBC
 Two High-High Level Switches
 Analogue Input (AI) Card
 Logic Solver Central Processing Unit (CPU)
 Digital Output (DO) Card
 Pneumatically actuated valves (7 off).

SIF Logic/Architecture (Part 2)

| Architecture | Voting | Limitations/Constraints | CCF Potential |
|----------------------|--------|-------------------------|---------------|
| Level detection | 1oo2 | N/A | N/A |
| Logic Solver | 1oo1 | N/A | N/A |
| Final element action | 7oo7 | N/A | N/A |

SIF Requirements

| SIL Target | SIL 1 | Demand mode | Low Demand |
|-----------------------------|------------------------|-------------------------|-------------------------|
| Final Element Response Time | ~2 minutes | Process Safety Time | ~24 hours ¹ |
| Proof Test Interval | 12 Months ² | PFD Required | 0.088 |
| Trip Condition | De-energise to trip | Max. Spurious Trip Rate | 0.1 / year ³ |
| Expected MTTR | 48 hours ² | Mission Time | 20 years |

¹ At a similar facility (ISO11), the four treatment vessels (1,400 Litres each) are used around twenty times a day. Assuming the same water consumption rate at Brooksby, this is about 28,000 Litres/day. Using Brooksby architectural drawings, an estimated 32,500 Litres is required to flood the entire Brooksby building by one inch. This means if the drains back up causing flooding, it would take slightly more than 24 hours to flood the Ground Floor of the Brooksby building.

² Pending validation by SIL Verification.

³ As a guide, the maximum spurious trip rate should be lower than half of the sum of all the initiating causes' frequencies.

| SIF Process Measurement Requirements | | | | |
|--------------------------------------|-------|-----------|-------------------|---------------------------|
| Component | Range | Accuracy | Trip Point | Validation Criteria |
| Level detection | N/A | +/- 10 mm | N/A (Fixed Point) | FAT, SAT (procedures TBC) |
| Logic Solver | N/A | N/A | N/A | |
| Final element action | N/A | N/A | N/A (Fixed Point) | |

| Additional SIF Requirements | |
|--|--|
| Safe State Definition | Removal of instrument air from the valve actuator of the 7 final elements. The fail-close valves then close. |
| Sources of Demand | <ul style="list-style-type: none"> Blockage in the common header, effluent line or in an individual main drainage. Manual valves 1101 and/or 1102 closed in error following maintenance. Control system fault leading to route to collection tanks closed simultaneously. Allowing collection vessel to overfill while transferring effluent back from the treatment vessel. Any manual valve upstream of drain manifold closed in error |
| Manual Shutdown | None within the SIF setup. |
| Reset after Shutdown | Two resets required: <ul style="list-style-type: none"> “Software reset” performed via the BPCS by Control Room Operator (CRO) after input shows healthy following a trip. Manual reset on the solenoid valve that supplies instrument air to the final element (pneumatically actuated valve). Valves can only be re-opened after BOTH resets have been performed. |
| Bypass Requirements | Yes, input bypass facility required for repair and maintenance. |
| SIF Faults and Failures and Required SIS Response | The system will trip upon: <ul style="list-style-type: none"> Level switch detecting liquid for longer than 30 seconds. Level switch fault for longer than 12 hours. Loss of power to instrument, logic solver, or solenoid valve. Loss of instrument air to valve. Detected open circuit in loop for longer than 12 hours. Detected short circuit in loop. Discrepancy alarm to be generated if final element (i.e., valve) still indicates “Open” 5 minutes after trip signal has been sent. This indicates that the valve has failed to close as required and allows operators to shut other manual valves as an alternative method of bringing the plant to a safe state. |
| Electrical Supply | Primary source of power shall be via the essential DRUPS power distribution system for the building. |

| SIF Application Program Requirements | |
|--|---|
| Logic Solver Tag | TBC |
| Other SIFs supported by the Application Program | (None) |
| SIS Interfaces | To BPCS for fault alarms, shutdown alarm, and to allow software reset from BPCS. |
| Security Access | Password protection to download and modify Application program |
| Communications Interfaces Requirements | Ethernet, Modbus IP and RTU field network Logic solver must not be connected to the internet. |
| Trip Signal Response Time | Less than 500 ms |
| Programming Requirements | Limited Variability Language (LVL) is preferred. Use of Full Variability Language (FVL) must comply with IEC 61508-3. |

Level R3

Level R3

Level F3

Level F3

Level F2

Level F2

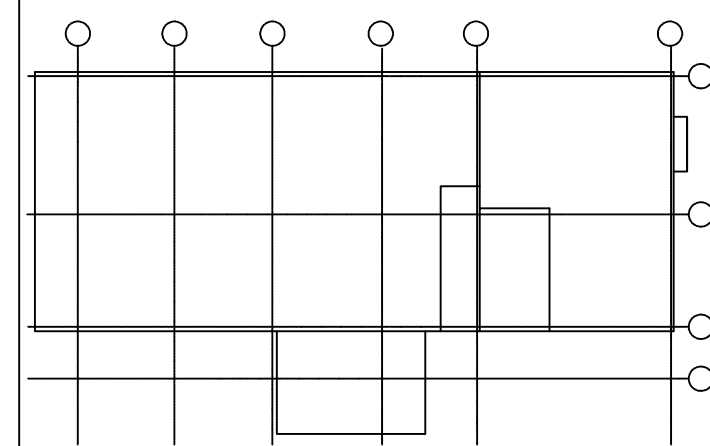
Level F1

Level F1

Level F0

Basement (Multiple Levels)

Key Plan:



NOTES:

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, STRUCTURAL ENGINEERS & SERVICES DRAWINGS AND SPECIFICATIONS.
- DO NOT SCALE FROM THIS DRAWING.
- ALL DIMENSIONS ARE IN MILLIMETERS.

Legend:

- Cat5 Softened Cold Water
- Cat5 Hot Water Flow
- Cat5 Hot Water with Trace Heating tape
- Cat5 Hot Water Return
- Cat5 Non Containment Wash Down
- Domestic Boosted Softened Water
- Domestic Softened Hot Water Flow
- Domestic Softened Hot Water with Trace Heating tape
- Domestic Softened Hot Water Return
- Animal Drinking Water
- Human Drinking Water

VALVE LEGEND

- IV ISOLATING VALVE
- DCV DOUBLE CHECK VALVE
- SLV STOP/LOCK VALVE
- TRV THERMAL RELIEF VALVE
- RV PRESSURE REDUCING VALVE

For valve details refer to Typical Room Schematic:
P800-KME-53-XX-DR-PH-0007

| | | | | |
|---------------------|----------|--|-----|-----|
| C07 | 16/01/23 | Issued as Construction Record Information | KME | CB |
| C06 | 17/05/22 | Minor updates along with CIS changes. Re-issued as Approved & Accepted as stage complete | KME | CB |
| C05 | 28/03/22 | Minor updates to SI arrangements. re-issued as Approved & Accepted as stage complete | KME | CB |
| C04 | 13/12/21 | Updated to recent design mods. re-issued as Approved & Accepted as stage complete | KME | CB |
| C03 | 18/08/21 | Updated to recent design mods. re-issued as Approved & Accepted as stage complete | KME | CB |
| C02 | 02/09/20 | Updated with minor design changes. Approved & Accepted as stage complete | KME | CB |
| C01 | 02/09/20 | Approved & Accepted as stage complete | KME | CB |
| P01 | 21/08/20 | Issued for review & comment | KME | CB |
| Rev | Date | Description | Crp | Cnd |
| CONSTRUCTION RECORD | | | CR | |



Mechanical & Electrical
Southern Cross, Baring View, Baringvale, Nangaparua, 6021 442
Tel: 0120 362301
Fax: 0120 362301

The Pitbright Institute

The Brooksbury Building

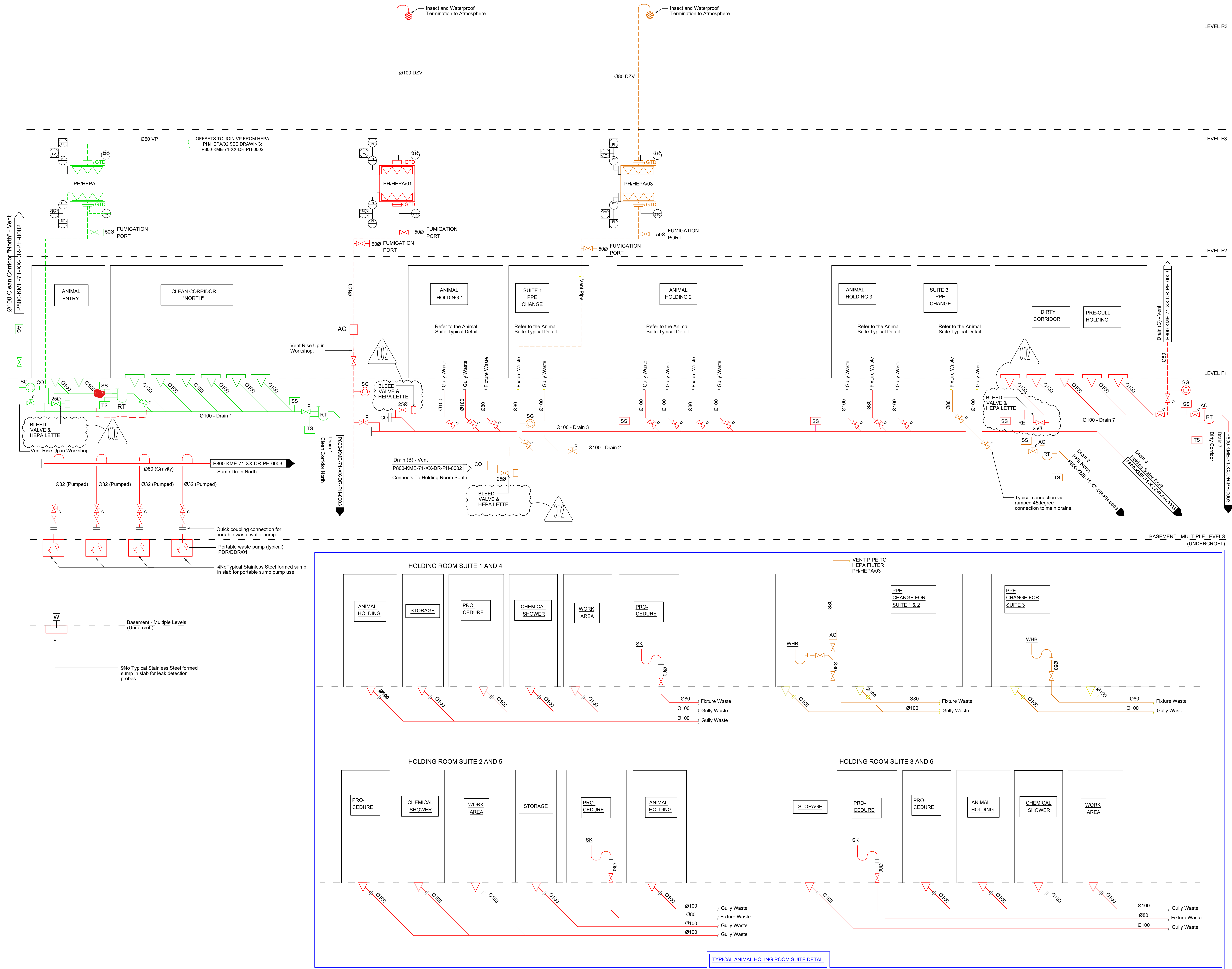
Public Health Services
Water Services Schematic
Sheet 1 of 4

Originator: KME, Checked: CB, Approved: CB

Code: NTS, A0, PUBLIC HEALTH

Proj No: P800-KME-53-XX-DR-PH-0001, Rev: C07

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Key Plan:

Legend:

- = Dirty Zone Drainage - Vent
- = Dirty Zone Drainage - Waste
- = PPE Zone Drainage - Vent
- = PPE Zone Drainage - Waste
- = Clean Zone Drainage - Vent
- = Clean Zone Drainage - Waste

Specific Abbreviations:

- RT = Running Trap
- SS = Surcharge Sensor
- TS = Trap Sensor
- FG = Floor Gully
- = Isolation Valve
- = Isolation valve, (BMS monitors closed status)
- = Channel Outlet
- = Floor Gully
- = V Clamp Connection

NOTES:

1. ALL DRAINAGE TO COMPLY WITH THE REQUIREMENTS OF BS EN 12056 PART 2 AND THE BUILDING REGULATIONS PART H.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH AECOM SANITATION AND RAINWATER DRAINAGE GA DRAWINGS.
3. FOR DETAILS OF PIPEWORK MATERIALS REFER TO PUBLIC HEALTH SPECIFICATION REF. No P800-KME-70-XX-SP-PH-0001.
4. ALL JOINTS AT GROUND FLOOR SERVING SINKS & WHBS TO BE FIXED VIA TRICLAMP TO ENABLE PIPEWORK TO BE DISMANTLED.

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|---------------------------------------|----------|--|------|------|
| 002 | 17/11/20 | Client DCR comments added. Re-issued as Approved & Accepted as stage complete. | KME | CB |
| 001 | 24/09/20 | Approved & Accepted as stage complete. | KME | CB |
| P01 | 21/08/20 | Issued for review & comment. | KME | CB |
| Rev | Date | Description | Orig | Chkd |
| Approved & Accepted as stage complete | | | A1 | |



Mechanical & Electrical

Southern Cross, Baring View, Basingstoke, Hampshire, RG21 4HG
Tel: 01256 362061
www.kier.co.uk

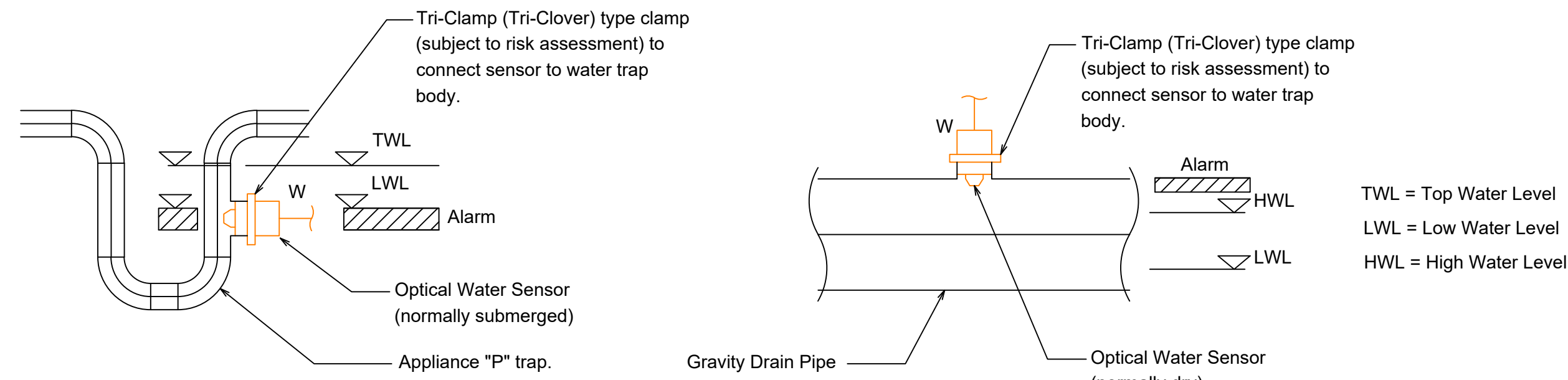
Client: The Pirbright Institute

Project: The Brooksbury Building

File: Public Health Services
Drainage Schematic
Sheet 1 of 4

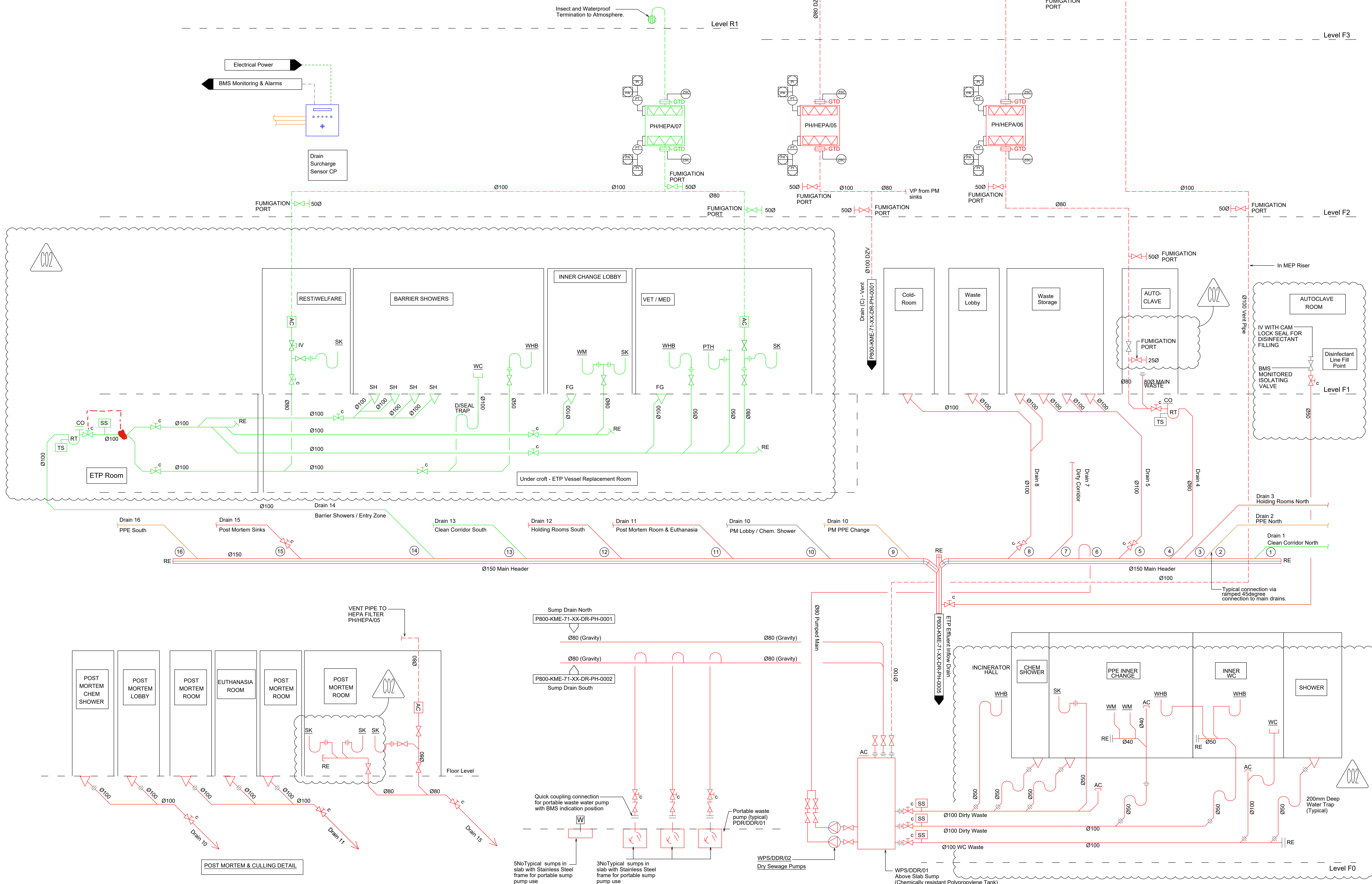
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|------------|---------------------------|----------|
| Organiser | Checked | Approved |
| KME | CB | CB |
| Code | NTS | AD |
| Discipline | PUBLIC HEALTH | |
| Proj No | P800-KME-71-XX-DR-PH-0001 | Rev: C02 |

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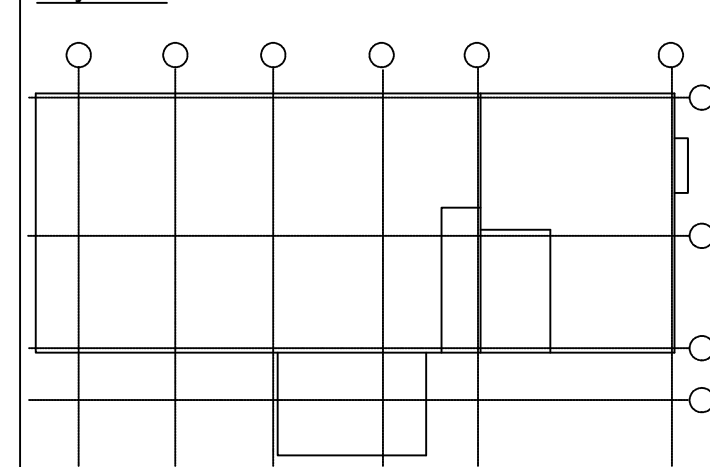


TYPICAL "RUNNING" TRAP WATER SENSOR DETAIL

TYPICAL DRAIN SURCHARGE SENSOR DETAIL



Key Plan:



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- = Dirty Zone Drainage - Waste
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Specific Abbreviations:

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- TS = Trap Sensor
- FG = Floor Gully
- = Isolation Valve
- = Isolation valve, (BMS monitors closed status)
- = Channel Outlet
- = Floor Gully
- = V Clamp Connection
- = Typical Drain Surcharge Sensor
- = Typical Running Trap

NOTES:

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| | | | | |
|-----|----------|---|------|------|
| CO2 | 17/11/20 | Client DCR comments added: Re-issued as Approved & Accepted as stage complete | KME | CB |
| CO1 | 24/09/20 | Approved & Accepted as stage complete | KME | CB |
| P01 | 21/08/20 | Issued for review & comment | KME | CB |
| Rev | Date | Description | Orig | Chkd |
| 01 | | Approved & Accepted as stage complete | A1 | |



Mechanical & Electrical
Southern Cross, Baring View, Bayside, Hampshire, RG21 4HG
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Client: The Pirbright Institute

Project: The Brooksbury Building

File: Public Health Services
Drainage Schematic
Sheet 3 of 4

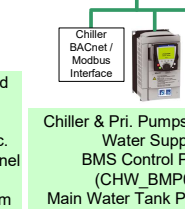
Operator: KME
Checked: CB
Approved: CB

Date: NTS
Drawn: AO
Discipline: PUBLIC HEALTH

Dwg No: P800-KME-71-XX-DR-PH-0003
Rev: C02

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BMS / PLC / SMS NETWORK OVERVIEW PHILOSOPHY



| | | |
|---|---------------------|---------------|
| Drawing Ref: P800-SCH-92-ZZ-DR-XX-5001 | Sheet No. 1 of 1 | Rev. P1-S2 |
|---|---------------------|---------------|