Urbanova Reference Site

# Siting

Roof top of WSU-owned building in Spokane University District

* Locations
  + Must be outdoors: weather station, Urbanova AQ node, PM monitor inlet
  + Must be indoors: trace gas analyzers, supporting devices
* Where on the roof
  + Put the PM monitor in dedicated enclosure or inside larger shelter?
  + Small tower for weather station and gas inlet?
  + Sufficiently distant from air handling equipment, fume hood exhausts?
  + Sufficient exposure? Not behind parapet or below penthouse?

## Power consumption

A single 15A (1800W) circuit should be sufficient.

|  |  |
| --- | --- |
| Description | Power (W) |
| weather station (WXT) | < 2, < 10 (heater on) |
| weather station (Airmar) | < 1, < 60 (heater on) |
| 4-channel radiometer heater | up to 6 |
| CO2 monitor (LI-840A) | 3.6 (typ), 14 (warmup) |
| pump for CO2 monitor | 12 |
| O3 monitor (Model 205) | 8 |
| NOx monitor (Model 405nm) | 16 (typ), 30 (warmup) |
| CO monitor (Model 48) | 100 |
| SO2 monitor (Model 43B) | 100 |
| MetOne BAM-1020 + pump | 170 to 550 |
| MetOne BAM-1020 + pump + inlet heater + shelter | 850 to 1250 |
| Thermo TEOM (model 1405) + pump | 940 |
| Thermo TEOM (model 1405) + pump + shelter | 1440 |

# Instrumentation

## Measurements

A wish list:

* Co-located Urbanova AQ node (T, P, RH, CO2, PM1/2.5/10)
* Weather
  + Air temperature
  + Barometric pressure
  + Relative humidity
  + 2D wind speed & direction
  + Precipitation
  + Insolation
* Trace gases
  + CO2
  + H2O
  + O3
  + NO/NO2
  + CO
  + SO2
* Particulates
  + PM1
  + PM2.5
  + PM10

Notes on instrument options:

* Vaisala WXT536 covers P/T/RH/WS/WD/rain, is heated, and supports analog inputs (K&Z CMP3 pyranometer, Vaisala RG13 tipping bucket, generic PT1000 thermistor); missing GPS
* Airmar 220WXH competitive with WXT536, has GPS and heater but no rain; temp disabled when heater is on, less accurate T/RH/WS below 2ºC
* Tracking solar intensity may be useful for understanding photochemistry
  + Include CMP3 for consideration because WXT536 supports direct integration
  + CNR1 is 4-channel (long/short-up/down), has heater, would require recalibration
* What size for PM monitor: PM2.5 or PM10? Is both possible?

## Candidate instruments

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Model (Make) | Vendor | Cost |
| weather station | WXT536 (Vaisala) | instrumentation2000.com | 3100 |
| weather station | 220WXH (Airmar) | starmarinedepot.com | 1900 |
| 4-chan radiometer | CNR1 (Kipp & Zonen) | *owned by LAR* | 300 (recalibration) |
| pyranometer | CMP3 (Kipp & Zonen) | Campbellsci | 1200 |
|  |  |  |  |
|  |  |  |  |
| CO2/H2O monitor | LI-840A (Licor) | *already purchased* | - |
| O3 monitor | Model 205 (2B Tech.) | *owned by LAR* | - |
| NOx monitor | Model 405nm (2B Tech.) | *owned by LAR* | - |
| CO monitor | Model 48 (TECO) | *LAR might have one* | - |
| SO2 monitor? | Model 43B (TECO) | *LAR might have one* | - |
|  |  |  |  |
| PM monitor | BAM-1020 (MetOne) | MetOne | awaiting quote |
| PM monitor | FDMS TEOM (Themo) | *WA ECY will loan long-term* | - |
|  |  |  |  |
| flow meter | 4043 or 4140 (TSI) | TSI | 1000 |

Suggested BAM-1020 configuration:

* BAM-1020 Beta Attenuation Monitor
* *Sampling kit:*
  + BX-FEM2.5 Accessories kit for EPA PM2.5 configuration *or*
  + BX-10 Accessories kit for EPA PM10 configuration
* *Pump:*
  + BX-121 / BX-122 High Capacity Gast Pump (rotary vane) *or*
  + BX-126 / BX-127 Low Noise Medo Pump (linear piston)
* BX-827 / BX-830 Smart Inlet Heater
* BX-965 Report Processor Option (digital comm expansion: buffered serial, Ethernet, USB)
* BX-864 Real-Time Module Option (get real-time PM trend output on unused input channel)
  + Would facilitate more direct comparison of PM trends with OPC-N2 in Urbanova unit
* *Ambient probe:*
  + BX-596 Ambient Temperature and Pressure Sensor *or*
  + BX-597 Ambient Temperature, Pressure, Relative Humidity Sensor
* *Enclosure:*
  + BX-903 Environmental Enclosure (heat+AC) *or*
  + BX-801 Standard 8’ Inlet Tube Kit with Roof Flange (if placed in larger outdoor shelter)

# Data Acquisition

Notes:

* Serial data available from nearly all devices
  + Smaller Campbellsci loggers very limited on serial ports
  + LAR has 4 port serial multiplexer for CRBasic dataloggers (unit is deprecated, compatibility OK but not assured)
* Raspberry Pi
  + Requires analog voltage input and voltage excitation hardware to interface with 4-chan net radiometer (I have no idea where to find suitable voltage excitation hardware)
  + Good choice for serial devices because of unlimited USB serial ports
  + More administrative overhead than dataloggers
* Things to control:
  + Valves for standard injection
* Ancillary monitoring
  + Sample flow rate through trace gas inlet
  + Status of uninterruptible power supply (via PC or Raspberry Pi)

## Integration Details

|  |  |  |  |
| --- | --- | --- | --- |
| Device | Interfaces | Protocols | Integration Expr. |
| WXT536 | SDI-12, RS-232/484/422 | SDI-12, NMEA 0183, proprietary ASCII | (WXT520) CRBasic |
| 220WXH | RS-232/422 | NMEA 0183 | (150WX) CRBasic, Python |
| CRN1 | 1x excitation input, 6x voltage output (2 require diff. input) | | CRBasic |
| CMP3 | 1x voltage output | | *none* |
| LI-840A | 2x voltage output, RS-232 | proprietary XML/ASCII | CRBasic, Python |
| Model 205 | 1x voltage output, RS-232 | proprietary ASCII | CRBasic |
| Model 405nm | 1x voltage output, RS-232 | proprietary ASCII | CRBasic |
| Model 48 | voltage output |  | CRBasic |
|  |  |  |  |
|  |  |  |  |
| BAM-1020 | voltage output, current output, RS-232, Ethernet (optional) | proprietary ASCII | *none* |
| TEOM 1405 | voltage output, RS-232 | AK protocol | *none* |
|  |  |  |  |
|  |  |  |  |
| 4043 or 4140 | voltage output, RS-232 | proprietary ASCII | CRBasic |

## Candidate DAS Hardware

|  |  |  |
| --- | --- | --- |
| Description | Interfaces | Cost |
| CR850 (incl. display) + NL201 | 3x diff. AIO, 2x VX, 2x UART, 1x RS-232 | 1600 |
| CR310 (no display, incl. network) | 3x diff. AIO, 2x VX, 1x UART, 1x RS-232 | 820 |
| CR6 (incl. network) + display | 12x U (= AIO, VX, SPI, I2C, UART) | 2100 |
| CR1000 + display + NL116 | 8x diff. AIO, 3x VX, 4x UART, 1x RS-232 | 2000 |
| CR3000 (incl. display) + NL116 | 14x diff. AIO, 4x VX, 3x IX, 4x UART, 1x RS-232 | 3300 |
| Raspberry Pi model 2 B+ (& accessories) | 26x DIO, 1x UART, I2C, SPI, USB | 200 |
|  |  |  |
|  |  |  |

Notes:

* CR310 & CR850
  + do not support external memory cards
  + do not have adequate serial device support without extra hardware
* CR6
  + Has faster CPU than CR1000 plus hardware floating point support
  + Requires expansion hardware to support 4-chan radiometer (CDM-A108, $1100)
* CR1000 & CR3000
  + Do not have enough serial ports without expansion hardware (but should be able to use deprecated SDM-SIO4 serial multiplexer)
  + Can easily support 4-channel net radiometer
* Raspberry Pi requires a lot of accessories (case, SD card, power supply, real-time clock or GPS, USB-serial adapters, USB hub and hardware for analog voltage input, if using 4-chan radiometer)

## Wiring Planning

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Device | Channel | CR6+CDMA108 | CR1000 | CR3000 | Raspberry Pi |
| WXT536 | serial data (SDI-12) | U1/2 (UART) |  |  | USB serial |
| CNR1 | data channels | CPI: DF1-4 |  |  | add-on board |
| heater excitation | CPI: X1 |  |  | ? |
| heater feedback | CPI: DF5-6 |  |  | ? |
| LI-840A | serial data (RS-232) | U3/4 (UART) |  |  |  |
| m205 | serial data (RS-232) | U5/6 (UART) |  |  |  |
| m405nm | serial data (RS-232) | U7/8 (UART) |  |  |  |
| BAM-1020 | serial data (RS-232) | U9/10 (UART) |  |  |  |
| 4043 | serial data (RS-232) | U11/12 (UART) |  |  |  |
|  |  |  |  |  |  |

Additional hardware:

* Uninterruptible power supply
* Tower or tripod for inlets and weather station
* Components for mounting in small 19” rack
* Trace gas inlet:
  + Vacuum pump
  + Flow meter
  + Cartridge filter for pump
  + PFA tubing, 25-50’ at 1/4" to 3/8”
  + PFA fittings
  + PFA 47mm filter housing (without filter, for bug screen)

# Maintenance & Automation

Questions:

* How frequently does particulate monitors require service?
  + Shortest service interval is monthly for BAM-1020 (cleaning/auditing)
* Use scheduled standard injections for trace gas monitor QA/QC? Easy for CO2, harder for NOx, not possible for O3?