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# ALINTA GAS NETWORKS

# GAS NETWORK HEATING VALUE MEASUREMENT FEASIBILITY STUDY AND MARKET SURVEY REPORT

**REVISION HISTORY**

| REV | DATE | BY | CHCK'D | APPR'D | COMMENTS |
|---|---|---|---|---|---|
| | | | | | |
| 1 | 21/02/05 | CS | PP PJB | [signature] | Issued for Client Approval |
| 0 | 30/11/04 | PJB | CS | PB | Issued for Client Approval |
| A | 20/10/04 | CS | PJB | IW | Issued for Client Review |

# 1. EXECUTIVE SUMMARY

AlintaGas Networks (AGN) requires an instrumented system to monitor the boundaries of rich and lean gas within their distribution network. A market survey and feasibility study has been undertaken by PCT Engineers, including budgetary costing.

The technologies investigated for possible use were transmitter style GCs, SG transducers, Speed of Sound / Thermal Conductivity devices and Calorimeters. Calorimeters were not suitable for this application and were not examined in detail.

The transmitter style GCs directly determine HHV. The need for storage of calibration and carrier gas is a disadvantage considering the installation sites are typically on suburban streets, however an additional pit would be required at each site regardless of the option selected.

The GasPT device determines HHV directly, without the need for high pressure gas storage on site. It is disadvantaged by the fact that it is a newer technology, with limited use and support outside of the UK. Significant changes in future gas composition will require manufacturer changes to the characterisation of the devices to ensure the continued accuracy.

The SG transducer devices are not recommended. They are a similar price to the transmitter style GCs, but will require additional programming and data manipulation to determine HHV and the overall measurement process will be inherently less accurate. It is also possible that future changes in gas composition from either source could result in the SG/HHV correlation method becoming invalid.

A significant capital investment will be required for this project, regardless of the final option selected. The GasPT was the cheapest option examined, followed by the Sarasota SG transducer and then ABB's BTU transmitter.

PCT is unable to make a definitive recommendation based on the investigation findings as no single device has demonstrated clear advantages over the other options. The final selection will depend on AGN's priorities and preferences.

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# 2. INTRODUCTION

AlintaGas Networks (AGN) requires an instrumented system to monitor the boundaries of rich and lean gas within their distribution network. This is not a straight forward application as all reviewed options have power, utility, security, sample disposal or ancillary requirements which are not easily accommodated in the allocated metropolitan locations. Market survey and feasibility studies have been undertaken by PCT Engineers, including budgetary costing. This report details the positive and negative aspects of the instruments proposed, estimates of capital and operating costs and discussions about the different solutions identified.

## 2.1. Background

AlintaGas Networks (AGN) is introducing soft zoning in its two metropolitan sub-networks. In this arrangement, gases from the Dampier Bunbury Natural Gas Pipeline (DBNGP) and Parmelia Pipeline are blended within the sub-networks. As the heating value of the gases can differ substantially, customers in each zone will be billed with an appropriate heating value. Regulations are currently being developed to impose a maximum difference between the Higher Heating Value (HHV) a customer is billed for and what they actually get, of 1 $MJ/Sm^3$.

Simulation of the sub-networks has already predicted the boundary areas, but the state regulator has requested actual on-line measurements to confirm these predictions. It is anticipated that up to 12 locations will require HHV monitoring to achieve this. The devices would need to be largely standalone (i.e. preferably solar powered, with a data logger and/or mobile phone modem). Issues such as capital, operating and maintenance cost, as well as the cost of equipment housing, consumables and power supplies are also relevant to the final selection. It is anticipated that about one quarter of the devices will need to be relocated each year, due to changing zone boundaries.

## 3. GAS ANALYSIS

While the original scope of work involved a market survey of devices that could measure HHV, instruments that can determine Specific Gravity (SG) have also been included based on analysis of DBNGP and Parmelia gas compositions over a twelve month period. This showed a strong (0.94) correlation between SG and HHV for DBNGP gas. The correlation for Parmelia gas was not as strong (0.70), though there was still a clear relationship. Additionally, there is a clear difference between the SGs of each stream, with an average difference of 0.037. 95% of samples show an SG difference between the two streams of between 0.0226 and 0.0508, therefore to maintain a 95% confidence interval, an SG measuring device must be accurate to at least ±0.0226. This is equivalent to about ±3.6% of SG. An alternative approach is to measure the variation in SG required to give a variation in HHV of 1 $MJ/Sm^3$. The Parmelia Gas requires the higher accuracy here, with a variation of 0.0051 in SG corresponding to a difference of up to 1 $MJ/Sm^3$ in HHV. If an accuracy of ±0.5 $MJ/Sm^3$ is required, SG must be accurate to within ±0.4%. As this is the more conservative approach, it is preferred when setting the specifications required for SG measurement.

Similar analysis was carried out for possible correlations between HHV and $CO_2$ or $N_2$ concentrations in gas but none were found. Graphical summaries of the analyses are given in Appendix A.

The correlation between SG and HHV provides an alternative method of distinguishing between the two gas supplies. Given the clear difference between the SG of each stream it should be possible to determine from the measured SGs whether DBNGP or Parmelia gas is being measured. The appropriate HHV could then be retrospectively applied based on the corresponding HHV measured at the inlet point, with an allowance for transit time. This method would require more manipulation of data than direct measurement of SG and a lower accuracy, though it may still be acceptable for use in confirming the computer model of gas distribution.

## 4. POSSIBLE SOLUTIONS

Three different methods of distinguishing between rich gas and lean gas in the AlintaGas distribution network have been identified. These are direct heating value measurement by the methods described below, specific gravity measurement by compensated density and speed of sound / thermal conductivity measurement. No one method has clear advantages over the others, so all three have been investigated and are examined below.

### 4.1. Direct Heating Value Measurement

The application of conventional gas calorimeters was considered and a number of products reviewed including Delta Instrument, COSA and Thermo Electron. The findings were that continuous power consumptions for these devices were in the range of several hundred watts and all of the reviewed devices required an instrument air supply. The utility requirements are therefore outside of the constraints identified by AGN for stand alone self powered measuring facilities.

Another option reviewed was the thermal conductivity detector calorimeter developed by Tokyo Gas. This device uses only one of the combined detection methods used by the GasPT discussed in section 5.3. This device relies only on a direct characterisation between thermal conductivity and heating value. PCT is of the opinion that this characterisation used without any other parameter correlation (such as speed of sound) is not appropriate where the measurement involves two differing and inconsistent gas mixtures and shall not be further considered.

Gas Chromatographs (GCs) have greatly reduced in size and cost over the past years and so called 'transmitter style' models are now available. While their accuracy and range of measurement is not as good as the larger models, it is more than acceptable for this application. One major advantage of these devices is that HHV is determined directly and accurately based on weighted summation of component heating values to international standards such as ISO-6976. Knowledge of chromatography is not required for operation and maintenance is generally accomplished by changing out modules. While the transmitter style GCs are considerably smaller than the older units, they still require bottles of high pressure calibration and carrier gas in order to operate and this additional space must be allowed for. The configuration for each site would include 1 x GC unit, sample conditioning unit, Helium (carrier) gas cylinder and a calibration gas cylinder in a new pit. The cylinder sizes could be reduced to 'D' size, while still maintaining acceptable cylinder change out timing, by reducing the number of samples per day. Cylinder location will a the major issue with these devices regardless of where they are mounted but location close to the sample point is preferred to reduce measurement delays due to gas sample transit time. An additional enclosure is required outside of the hazardous area to contain the data logging equipment which can also be utilised for the battery and GSM modem.

Two gas chromatograph vendors responded to our enquiry by the required date and the models proposed are presented below. Another gas chromatograph which may be considered if proceeding to the next phase is the Danalyser 700 although this has a nominally higher power consumption and was not reviewed in detail for this reason.

#### 4.1.1. ABB BTU Transmitter

ABB's BTU transmitter has internal data logging and averaging however there is still a requirement for an external datalogger to achieve the extended logging and dial out on alarm features required by Alinta. Serial communications are available. Cycle times as low as 3 minutes are possible however to reduce carrier gas cylinder size it is proposed to extend the cycle time up to 15 minutes.The repeatability of the unit is quoted as ±0.05%, though the effect of the calibration gas needs to be added to this to determine overall accuracy. The accuracy of these units is expected to be significantly better than required for this application.

A very small sample and carrier gas exhaust flow will require disposal, flow rate estimated at less than 10 L/hour. An additional sample bypass gas flow may be considered to provide a shortened sample response time. The ABB specifications call for a minimum operating sample pressure of 100 kPag. This means that at the low pressure locations (40 kPag) the ABB unit could not be utilised. ABB is currently considering the low pressure requirement however no response has been received at this time.

A 100W 12V 200aH solar power supply and batteries was included in the vendor's proposal, based on the unit's low power (6W continuous, 25W startup) usage however a much cheaper quote has been obtained from a solar panel vendor.

This GC is familiar to PCT and acceptable for the measurement application for sites operating at greater than 40 kPag. Pressure boosters could be sourced by ABB to meet the required inlet sample pressure specification, but not without additional power requirements.

#### 4.1.2. Siemens' Microsam Process Gas Chromatograph

POGC now market Siemens' Microsam GC in Australia. This has a cycle time of 150 seconds, with an adjustable number of cycles per hour. The repeatability of the unit is about ±0.05% of HHV, though as with other GCs the quality of the calibration gas impacts on the overall accuracy.

A very small sample and carrier gas exhaust flow will require disposal, flow rate estimated at less than 10 L/hr.The units do not have any internal data logging capabilities and require a separate logging unit, housed in a separate enclosure outside the hazardous area.

The Microsam units can handle sample pressures down to 10 kPag, meaning that even low pressure locations could be sampled by the standard arrangement.

A solar power supply has been included in the vendor's proposal, based on the unit's 24V DC, (18 W continuous, 50 W startup) power usage, but a slightly larger unit would be required to power the external datalogger.

This device is new to Australia and there is no installed base in this country. About 50 units have been installed in the UK. The vendor intends to have two technicians trained in the installation and use of these GCs, however these people will be based in Sydney.

#### 4.1.3. Yamatake HGC 303 Heat Value Gas Chromatograph

The vendor did not respond to our query in time for inclusion in this report. A review of the device data sheets reveal that it is similar in installation requirements and specification to the other GC's assessed in this report. One significant issue is that the valves are pneumatically switched and in this installation would be switched by carrier gas. The gas usage would need to be considered during the equipment specification and procurement phase. The sample inlet pressure is quoted at 7 psi, which should be adequate for use at the low pressure stations. The power consumption is comparable to the ABB unit at 5 to 50 VA. There are currently no installed units in Australia however there are believed to be some units ordered and an intention to build a service base.

## 4.2. Specific Gravity Measurement

Specific Gravity or gas density transmitters are based on the principle of a resonating or vibrating cylinder. The density of the gas flowing through the chamber changes the resonant frequency of the cylinder. An electronic measurement of the vibration frequency determines the gas density, which is converted to standard conditions of pressure and temperature for SG determination. It follows that the system includes pressure and temperature measurement devices located in close proximity to the measurement chamber.

SG transducers are typically a marginally smaller size than the gas chromatograph, though external sample conditioning equipment will be needed for these applications. Based on the typical sites inspected to date a new pit will be required at most locations. The standard configuration involves an SG transducer in the new pit with sample conditioning equipment. An additional enclosure is required outside of the hazardous area to contain the data logging equipment, which can also be utilised for the battery and GSM modem.

The two main suppliers of these devices have responded to the enquiry, and their instruments are examined below.

### 4.2.1. Solartron Mobrey

Solartron's 3098 SG Transducer has an analog output proportional to gas SG. In addition to the pit mounted sample conditioning and sensor assembly, there is a signal convertor which will be mounted in the safe area enclosure. A sample gas exhaust flow must be disposed of at between 0.7 and 216 L/hour.
The quoted accuracy of ±0.1% of reading is well within the accuracy required for this application. It should be noted however that PCT's experience is that the actual accuracy of these types of units can be less than stated by the vendor.

Two calibration cylinders are required (methane and nitrogen) but unlike GCs, calibrations could be carried out manually and periodically with transportable cylinders.

Expected continuous power consumption is relatively high at 25.5 W, though much of this is used by the signal converter and data logger. We note that the data logging capabilities of the signal converter may meet the Alinta requirements however there would be no dial out and alarming function as required. Consequently we have costed this unit on the understanding that Alinta's standard datalogger would be used.

A minimum supply pressure of 690 kPag is required for operation of the unit. This is adequate for the high pressure sites, but not for the low pressure (40 kPag) locations.

This device appears acceptable for the measurement application with the exception of the sample gas low pressure limitation.

### 4.2.2. Sarasota SG900

Sarasota's SG900 is a transmitter only with an integral converter and no data logging function. The arrangement would be similar to that described above with the analyser located in the new pit and a data logger installed in the nearby enclosure.

A sample gas exhaust flow requires disposal at the more significant rate of between 240 and 1200 L/hour. The dispersion of this larger gas volume may need to be considered in line with AS/NZS-2430 to determine the acceptable proximity of the data logger enclosure to the discharge point.

Online calibration is not necessary under normal conditions. In the long term calibrations would necessitate removal of the sensor and return to the factory for recalibration. In PCT's opinion this would be necessary every two to five years for each instrument based on our experience with densitometer installations.

As with many transmitters, the accuracy of the unit depends on a number of factors, but is expected to give an accuracy of around ±0.1% of SG reading (this does not take into account the uncertainty in the HHV inference from SG value). This is well within the accuracy required for this application. It should be noted again that PCT's experience is that the actual accuracy of these types of units can be less than stated by the vendor.

The unit itself requires 1.25 W of power. The datalogger proposed by the vendor uses 25 W maximum, though this would be replaced with the AGN standard logger system as described in this document.

The unit can operate at down to 40 kPag, which makes it suitable for AGN's low pressure sites.

This device appears acceptable for the measurement application.

## 4.3. Speed of Sound Measurement

The speed of sound in gas is related to the molecular weight and therefore SG. Ultrasonic speed of sound measurement combined with thermal conductivity detectors are used to infer heating value in these instruments. There is no rigorous algorithm to describe the heating value correlation and therefore the proponents of these combined technologies are required to characterise the instruments for the range of gas or gases to be measured.

The standard configuration involves a transducer in the new pit with sample conditioning equipment. An additional enclosure is required outside of the hazardous area to contain the data logging equipment, which can also be utilised for the battery and GSM modem.

Three examples of this technology were located during this review.

Osaka Gas is promoting an ultrasonic 'calorimeter', which is effectively an ultrasonic flowmeter. The HHV correlation in this device is therefore dependent on only the molecular weight and it follows that this solution provides less accuracy than the devices also utilising the measured thermal conductivity. In addition to this limitation, there is no indication that this device is commercially available and therefore we consider it does not warrant further investigation.

The Calorsound by Del Mar (France) was revealed at a later stage in the review and the device is represented in Australia by POGC. It essentially uses the same central "cell" as Advantica's GasPT discussed below, with sampling valves added by Del Mar. Consequently performance specifications are identical to the GasPT. Dealings with POGC have been extremely slow and on occasions it was clear that queries were going from POGC to Del Mar to Advantica and back again. POGC withdrew from the quotation process at a late stage after Del Mar ceased contact with them. The arrangement between Del Mar and Advantica is apparently no longer in place and therefore PCT recommend that Del Mar's device not be pursued any further.

### 4.3.1. GasPT Transmitter

The GasPT device previously marketed by Invensis and now distributed by Advantica measures the speed of sound, thermal conductivity, temperature and pressure of a gas sample. These are combined via software to infer HHV, and if required SG, based on a characterisation or calibration of a typical gas composition.

The GasPT comes in a sample conditioning enclosure similar to the SG analysers. It would also require an external data logger and safety interface unit in a non-hazardous enclosure. There are no carrier or calibration gas requirements. As with the other options, an additional pit will be needed at each site to accommodate the GasPT device and its associated sample conditioning equipment.

Advantica have confirmed that both gas sources can be properly characterised by the device. The quoted HHV accuracy of about ±1% (approximately ±0.4 MJ/Sm$^3$) is inferior to the HV transmitter but marginally better than using HV inferred from SG. Literature on the GasPT quotes a HV accuracy of ±0.5% of HHV, so the ±1% figure is considered realistic, given their lack of experience with characterisation of Australian natural gases. Significant changes in the future of gas composition from either supply source will require re-characterisation of the calculations used in the GasPT.

The gas sampled by the device needs to be vented, at a rate of between 30 and 120 L/hour depending on the sample time which can be varied between 2 and 250 seconds. To avoid larger gas dispersion radius at the sample vent it is recommended to sample over the longer time period.

The device is intrinsically safe and is supplied with a barrier, though neither are certified to Australian Standards and would require a Statement of Opinion.

The GasPT uses 100 mA at 24 VDC (2.4 W), which is the lowest power requirement of all options reviewed. The power usage of an external datalogger would also need to be considered.

The GasPT technology is not as mature as the transmitter GCs and SG transducers. A user list has been supplied, showing 17 UK applications, mainly on gas transmission systems. A further 27 units are used to analyse LNG for gas engine tuning for Osaka Gas in Japan. Australian experience and support can be seen to be limited, though Advantica have been more responsive than the previous owner of the GasPT technology (Invensis). The unit currently marketed is a new model from that previously considered by AGN and based on the specifications and vendor responses is considered suitable for this application.

## 5. DISCUSSION OF OPTIONS

Based on the existing gas supply compositions, vendor data and specifications reviewed, the three technologies discussed above are each considered to be capable of delivering the results desired by AGN. Despite this consideration, each technology has limitations and uncertainties and there are differences in cost and maintenance requirements as discussed below.

Based on the site visits conducted, it is accepted that available space is likely to be a problem at most of the intended sites. It was agreed with AGN that a new pit be considered for all sites.

For all options a Unidata Starlogger data logger and Wavecom GSM modem have been proposed to provide the configurability of data storage, data access and dial out alarming features consistent with existing Alinta metropolitan field measurement facilities. Solar panels and batteries are required to power the instruments and communications devices. For all options it is proposed to install a metal pole to support and elevate the solar panel and provide a safe discharge point for the sample stream.

The devices reviewed are all certified to overseas standards equivalent to a Zone 1 hazardous area but a Statement of Opinion (SoO) will be required to confirm and document compliance with the Australian certification scheme.

## 5.1. Transmitter Style GCs

The transmitter style GCs are proven technology that directly output the desired HHV. Their accuracy is excellent and their power usage low. This form of GC is much less complicated to operate and maintain than a traditional process GC, and minimal specialist skills are required to operate them, however they are still the most complicated and maintenance intensive of the reviewed technologies. Maintenance is typically performed by swapping out modular parts. They have on board diagnostics availability and a switched output which could be used to dial out an alarm.

Negative aspects of this technology are the need to store high pressure calibration and carrier gas near the GC, and the fact that a small sample gas stream requires venting. These are both concerns given that the location of the installation points is typically on suburban streets. It is noted however that all of the technologies examined require the disposal of a sample gas stream.

Of the two transmitter style GCs examined in detail, ABB's BTU transmitter is a similar price to the Microsam and has a low pressure limitation on the sample pressure. It is a more proven unit in Australia though, with local support available. If the project were to progress to a tendering phase we consider that the Yamatake, Yokogawa and Danalyser GC vendors should also be invited to participate.

## 5.2. Specific Gravity Transducers

Densitometers or SG transducers can be used to determine the SG of the gas sampled. As there is a definite difference in SG between the two inlet gas streams, measurement of SG is a way of determining the proportion of each gas passing by that point. This could then be correlated with the HHV measured by a GC at the inlet point to allocate a HHV to the SG measurement point. In the case of mixed gas flows, the HHV of the two gas supplies could be proportioned based on the measured SG vs the two inlet SGs. The responsible regulator would need to be convinced of the validity of this approach.

This is clearly a less accurate method than direct measurement of HHV and requires more manipulation of data. In addition, PCT's experience is that these devices are often less accurate in practical operating and maintenance situations than quoted by the vendor. There are no on board diagnostics available with the SG transducers and the logger would be configured to dial out an alarm based only on signal limits. We note that although these correlations provide an acceptable separation between the two inlet gas streams based on the range of current gas composition, future changes in gas supply composition may result in overlapping correlations. In this case the inference basis could be rendered invalid. The SG transducers require a much larger disposal flow than the other technologies and this would need to be considered in the vent and pole design.

The overall cost of ownership of Sarasota's SG transducers is cheaper than ABB's transmitter style GC and they do not require storage of calibration and carrier gas at site. Safety concerns have been raised about the use of some models of densitometer before, however these devices would be operating at relatively low pressures.

Of the two devices examined in detail, although the Sarasota unit is cheaper than Solartron, the Sarasota device also has a much larger gas stream to vent. Both units are equally well known in the industry, though there has been a definite trend away from their use in recent years, in favour of GCs.

## 5.3. GasPT Transmitter

Advantica's GasPT device is a new version of the 'Tracker' that was previously examined by AGN. Advantica has taken over responsibility for the Tracker since it was previously considered and has provided more assistance than the company originally marketing the device.

The GasPT measures speed of sound, thermal conductivity, pressure and temperature. These are combined with calibration data to infer HHV. Advantica has examined typical gas compositions for the DBNGP and Parmelia gas supplies and confirmed that the GasPT can determine their HHV to an accuracy of $\pm1\%$.

The GasPT possesses many of the advantages of the SG transducers, but not the same negative aspects. Its expected accuracy for inferring HHV is as least as good as the SG transducers as it has an extra degree of freedom in its thermal conductivity measurement (the GasPT speed of sound can be closely correlated to SG). There is the advantage that the GasPT HHV inference is undertaken within the device electronics without the need for manipulation of data and regression analysis of SG vs HHV as will be required for the SG option. It does not require calibration or carrier gas, and can be considered a 'set and forget' type transmitter however as with the SG devices, ongoing calibration checks would be required to confirm that the correlations and measurements are still within tolerance. One clear advantage of this technology is the very low power requirement (2.4 W for GasPT) and the resultant reduction in solar panel size and pole construction. The costing is therefore based on a solar panel in the top of the safe area enclosure as with existing AGN data logger installations. There are no on board diagnostics available with the GasPT transducer and the logger would be configured to dial out an alarm based only on signal limits. Its main disadvantages are the fact that this is a newer technology with a lack of experience and technical support outside of the UK.

The GasPT technology appears to be maturing and gaining acceptance and it does appear to be a feasible option for this application.

## 6. SITE AND INSTALLATION CONSIDERATIONS

The following practical issues related to the sites and installation of equipment are highlighted for consideration:

- Housing for datalogger / Instruments / gas cylinders,
- Elevated sample vent,
- Solar panel.
- Data logging and GSM modem access.

After reviewing the available space in the existing pits and enclosures it is considered that for each option viewed, it will be required that the sampling system and transmitter/analyser will be installed in a new stand alone pit at each site. For the GC option, the pit will need to be larger to house two high pressure gas cylinders. As the pit will contain gas sampling systems and will not be adequately ventilated the area within the pit will be classified as Zone 1. In addition to the pit, a safe area enclosure is required to house non certified equipment such as the data logger, GSM modem, battery and in some cases the vendor safe area devices. Each option has a requirement for a sample gas discharge which requires a pole to elevate the hazardous area at the discharge point out of reach or proximity to passers by or vehicles. As a solar panel will be required for all of the options and the size is expected to exceed the top area of the safe area enclosure, the pole can be utilised to elevate the solar panel to reduce the possibility of vandalism. The safe area enclosure can be mounted onto the pole and would need to be of rugged design as utilised in existing AGN field mounted logger panels, to withstand vandalism or possible vehicle impact A fully sealed battery and a charger regulator shall be installed within the cabinet.

Estimated solar panel sizes for each option are as follows:

| Device | Panel Area ($m^2$) |
|---|---|
| ABB BTU Transmitter | 1.12 |
| Siemens Microsam GC | 3.78 |
| Yamatake GC | 3.78 |
| Sarasota SG Transducer | 0.42 |
| Solartron Mobrey SG Transducer | 0.59 |
| Advantica GasPT | 0.59 |

The solar panel requirements for the Siemens Microsam and Yamatake GCs place them at a disadvantage due to the large area required to power them and it is likely that two separate panels would be required for single pole mounting.

To minimise sample times the new pit should be as near as practicable to the existing pit to minimise sample lengths. Where pressure reduction is required this should be done in the existing pit to maximise sample velocity. Where the sample times are prohibitively slow, a fast loop bypass may be considered however the effect of discharging more gas at the discharge vent, such as smell and an increased hazardous area, must be considered.

AGN has expressed a preference to maintain a data retrieval method consistent with their existing systems. Therefore all options have been considered with the following equipment;

- Unidata Starlogger
- Wavecom Fastrack Mk II GSM modem
- Disk antenna

A thick walled aluminium housing shall be provided which is consistent with the existing AGN data logger enclosure construction.

# 7. COSTING CONSIDERATIONS

The total budget installed costs of each of the options discussed in this report are estimated here at +/- 15% accuracy for major equipment costs. Ancillary and installation costs shown in this section are +/- 25% estimates. Operational costs are considered no better than +/- 30% due to a number of assumptions made during the costing process. Confirmation of all estimates should be sought before placing any purchase orders.

Based on the three typical sites inspected, it is expected that new pits will be needed to accommodate the devices regardless of the technology used. Accordingly, allowances have been included for new pits at all sites. In practice it may be possible to install some SG transducer or GasPT devices in existing pits, but this will need to be decided on a site by site basis.

Engineering support has been included which is based on outsourcing of detailed design, specification preparation, tender reviews, contractor supervision and contractor work-pack preparation.

An amount has been included for reconciling the Heating Value information into the billing system each month. For the SG measurement option this amount is larger, taking into account the requirement for SG to HHV inference prior to billing reconciliation.

## 7.1. Transmitter Style GCs

### 7.1.1. ABB BTU Transmitter

Capital Cost Summary

| **Cost per site** | |
|---|---|
| BTU Transmitter (non- manifold version) | $32,235 |
| Sample conditioning equipment and carrier / calibration gas | $9,505 |
| Heavy wall Aluminium enclosure | $2,500 |
| New Pit | $20,000 |
| Solar power supply, incl. battery | $1,690 |

| | |
|---|---|
| Pole for vent and solar panel | $2,500 |
| Data Logger/modem | $2,200 |
| Installation | $5,000 |
| **One only** | |
| Laptop computer | $4,000 |
| Statement of Opinion for use in Hazardous Area | $4,000 |
| One complete spare unit | $32,235 |
| Recommended spare parts | $17,500 |
| Engineering support | $40,000 |
| **Total for 12 sites** | $1,005,295 |

Operational Cost Summary per year, averaged where appropriate.

| | |
|---|---|
| **Cost per site/year** | |
| 4 half day visits per year x 1 technician for cal gas change out and calibration data checks. | $1,600 |
| Two ABB site callouts for each unit in ten year life span. $1000/callout. | $500 |
| 1 bottle calibration gas/site/ year (D size) | $1,000 |
| 2 bottles carrier gas/site/year (D size) | $750 |
| Spare parts replacement (estimated only) | $500 |
| Modem, data logger, power supply spares. Phone line costs. | $200 |
| Data reconciliation – 1 person day each month | $640 |
| **Total for 12 sites/year** | $62,280 |

See note below regarding periodic relocation costs. ABB quotation includes G size cylinder supply whereas D size are required. Potential cost reduction of $2,000+ per site.

### 7.1.2. Siemens Microsam GC

Capital Cost Summary

| | |
|---|---|
| **Cost per site** | |
| Microsam | $32,880 |
| Sample conditioning equipment | $8,538 |
| Carrier / calibration gas | $1,300 |
| Heavy wall Aluminium enclosure | $2,500 |
| New Pit | $20,000 |
| Solar power supply, incl. battery | $5,984 |
| Pole for vent and solar panel | $2,500 |
| Data Logger/modem | $2,200 |
| Installation | $5,000 |
| **One only** | |
| Laptop computer | $4,000 |
| Statement of Opinion for use in Hazardous Area | $4,000 |
| One complete spare unit | $32,880 |
| Recommended spare parts (est) | $17,500 |
| Engineering support | $40,000 |
| **Total for 12 sites** | $1,069,204 |

Operational Cost Summary per year, averaged where appropriate.

| | |
|---|---|
| **Cost per site/year** | |
| 4 half day visits per year x 1 technicians for cal gas change out and calibration data checks. | $1,600 |
| Two Siemens site callouts for each unit in ten year life span. $1000/callout. | $500 |
| 1 bottle calibration gas/site/ year (D size) | $1,000 |
| 2 bottles carrier gas/site/year (D size) | $750 |
| Spare parts replacement (estimated only) | $500 |
| Modem, data logger, power supply spares. Phone line costs. | $200 |
| Data reconciliation – 1 person day each month | $640 |
| **Total for 12 sites/year** | $62,280 |

See note below regarding periodic relocation costs.

## 7.2. SG Transducers

### 7.2.1. Solartron

Capital Cost Summary

| | |
|---|---|
| **Cost per site** | |
| Solartron SG Transducer | $26,400 |
| Signal Converter | $8,400 |
| Regulation and Control Panel | $1,000 |
| Heavy wall Aluminium enclosure | $2,500 |
| New Pit | $20,000 |
| Solar power supply, incl. battery | $934 |
| Pole for vent and solar panel | $2,500 |
| Data Logger/modem | $2,200 |
| Installation | $5,000 |
| **One only** | |
| Laptop computer | $4,000 |
| Statement of Opinion for use in Hazardous Area | $4,000 |
| One complete spare unit | $34,400 |
| Spare sensor unit for use during calibration at factory | $26,400 |
| Recommended spare parts (est) | $5,000 |
| Discount (5%) | ($45,000) |
| Engineering support | $40,000 |
| **Total for 12 sites** | $996,008 |

Operational Cost Summary per year, averaged where appropriate.

| | |
|---|---|
| **Cost per site/year** | |
| 2 half day visits per year x 1 technicians for calibration checks. | $800 |
| 1 bottle calibration check gas/year to be used for all sites (D size) | $100 |

| | |
|---|---|
| Two factory calibrations per ten years per site including shipping. | $400 |
| Spare parts replacement (estimated only) | $200 |
| Modem, data logger, power supply spares. Phone line costs. | $200 |
| Data reconciliation – 2 person days each month | $1,280 |
| **Total for 12 sites/year** | $35,760 |

See note below regarding periodic relocation costs.

### 7.2.2. Sarasota

Capital Cost Summary

| | |
|---|---|
| **Cost per site** | |
| Sarasota SG Transducer | $26,900 |
| Regulation and Control Panel | $1,000 |
| Heavy wall Aluminium enclosure | $2,500 |
| New Pit | $20,000 |
| Solar power supply, incl. battery | $841 |
| Pole for vent and solar panel | $2,500 |
| Data Logger/modem | $2,200 |
| Installation | $5,000 |
| **One only** | |
| Laptop computer | $4,000 |
| Statement of Opinion for use in Hazardous Area | $4,000 |
| One complete spare unit | $34,400 |
| Spare sensor unit for use during calibration at factory | $26,400 |
| Recommended spare parts (est) | $5,000 |
| Discount (5%) | ($45,000) |
| Engineering support | $40,000 |
| **Total for 12 sites** | $800,092 |

Operational Cost Summary per year, averaged where appropriate.

| | |
|---|---|
| **Cost per site/year** | |
| 2 half day visits per year x 1 technicians for calibration checks. | $800 |
| 1 bottle calibration check gas/year to be used for all sites (D size) | $100 |
| Two factory calibrations per ten years per site including shipping. | $400 |
| Spare parts replacement (estimated only) | $200 |
| Modem, data logger, power supply spares. Phone line costs. | $200 |
| Data reconciliation – 2 person days each month | $1,280 |
| **Total for 12 sites/year** | $35,760 |

See note below regarding periodic relocation costs.

## 7.3. GasPT Transmitter

Capital Cost Summary

| | |
|---|---|
| **Cost per site** | |
| GasPT | $18,543 * |
| Regulation and Control Panel | incl |
| Heavy wall Aluminium enclosure | $2,500 |
| New Pit | $20,000 |
| Solar power supply, incl. battery | $1,109 |
| Pole for vent and enclosure support | $1,500 |
| Data Logger/modem | $2,200 |
| Installation | $5,000 |
| **One only** | |
| Laptop computer | $4,000 |
| Statement of Opinion for use in Hazardous Area | $4,000 |
| One complete spare unit | $18,543 |
| Recommended spare parts (est) | $3,000 |
| Engineering support | $40,000 |

| | |
|---|---|
| **Total for 12 sites** | $679,767 |

- Based on an exchange rate of £1 = A$2.4725

Operational Cost Summary per year, averaged where appropriate.

| **Cost per site/year** | |
|---|---|
| 2 half day visits per year x 1 technicians for calibration checks. | $800 |
| 1 bottle calibration check gas/year to be used for all sites (D size) | $100 |
| Two factory re-characterisations per ten years (est $6,000 each) | $1,000 |
| Spare parts replacement (estimated only) | $200 |
| Modem, data logger, power supply spares. Phone line costs. | $200 |
| Data reconciliation – 1 person day each month | $640 |
| **Total for 12 sites/year** | $35,280 |

See note below regarding periodic relocation costs.

## 7.4. Relocation Costs

It is anticipated that about 3 of the 12 installations will be moved to new locations each year. While there are minimal capital costs associated with this, there will still be costs involved with the relocation, mainly related to removal of the equipment and reinstalling it elsewhere. The general relocation cost is estimated at only $2000.00 for labour and shipment however when moved to a location without an additional pit, pole or enclosure an additional amount of $25,000 per relocation can be assumed for these items

The relocation costs are expected to be similar for each type of device, with the bulk of the cost coming from the requirement from a new pit at each new site. A total relocation cost of $30,000 per site, including removal and installation, is estimated.

# 8. CONCLUSION

PCT is unable to make a definitive recommendation based on the investigation findings as no single device has demonstrated clear advantages over the other options. The final selection will depend on AGN's priorities and preferences.

The SG transducer devices are not recommended, as they are a similar price to the transmitter style GCs, but will require additional programming and data manipulation to determine HHV and the overall measurement process will be inherently less accurate. It is also possible that future changes in gas composition from either source could result in the SG/HHV correlation method becoming invalid. The higher sample discharge rate in the metropolitan area is undesirable, however the lack of calibration or carrier gas on site is considered an advantage for this solution.

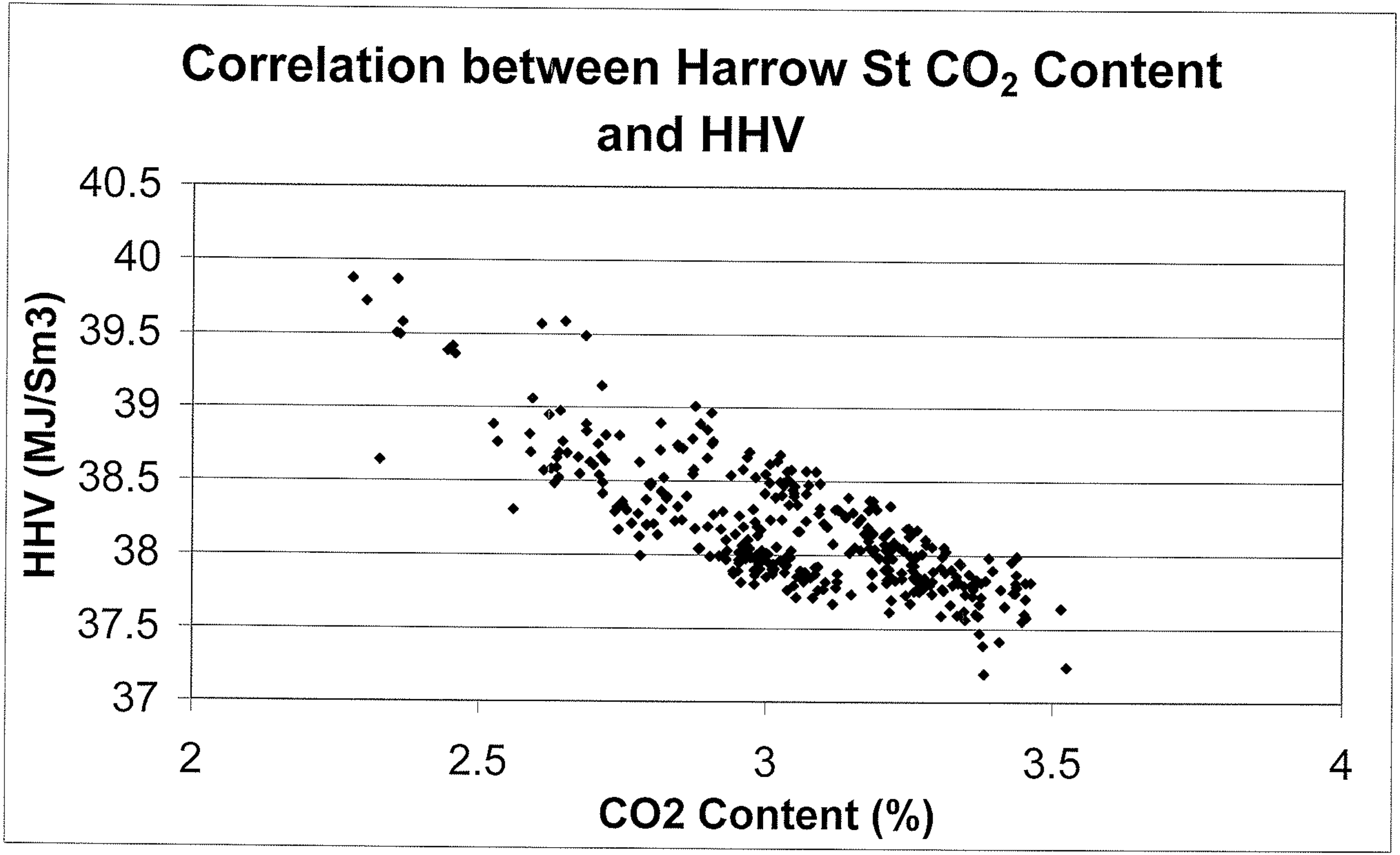
The transmitter style GCs directly determine HHV and the ABB unit has on-board diagnostic capabilities. The integrated design of the ABB unit requires much less power and therefore less substantial solar power source, however it is only suitable for gas supply pressures above 40 kPag. The need for storage of calibration and carrier gas is a disadvantage considering the installation sites are typically on suburban streets, however as a pit is being considered for all options the cylinder storage can be accommodated with minimal additional cost.

The GasPT device determines HHV directly, without the need for high pressure gas storage on site. It is disadvantaged by the fact that it is a newer technology, with limited use and support outside of the UK, possibly requiring interface with Advantica to characterise for the AlintaGas. Significant changes in future gas composition will require manufacturer changes to the characterisation of the devices to ensure the continued accuracy.

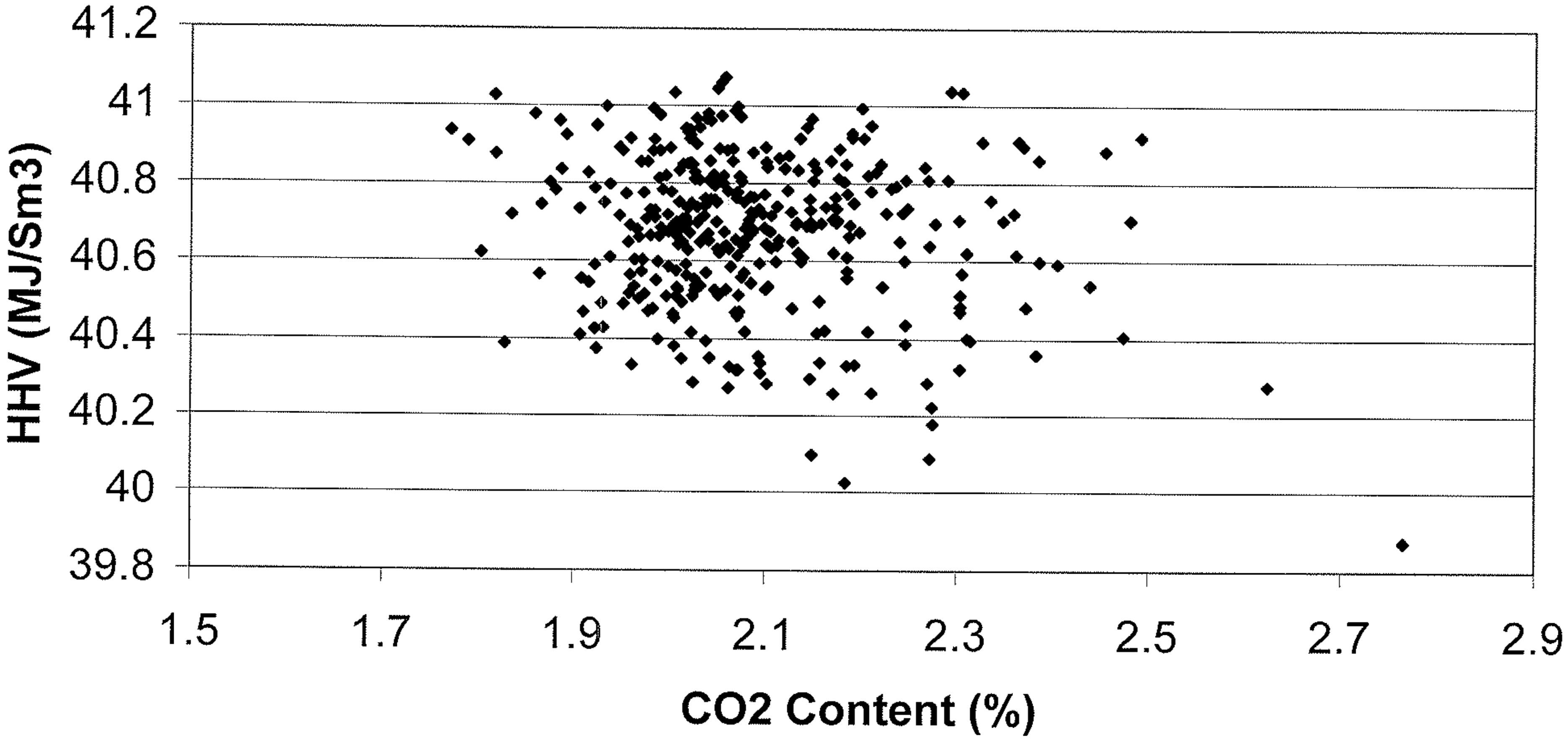
A significant capital investment will be required for this project, regardless of the final option selected. The GasPT was the cheapest option examined, followed by the Sarasota SG transducer and then ABB's BTU transmitter. PCT is of the opinion that the SG analyser should not be further considered due to the reasons stated above. Of the remaining two technology options the GC, while clearly more expensive to supply and maintain, is proven in similar service and will correctly measure any future gas compositions. The GasPT would be less expensive to supply and maintain however there are unresolved uncertainties regarding the characterisation for the Alinta gas, which must be resolved prior to proceeding.

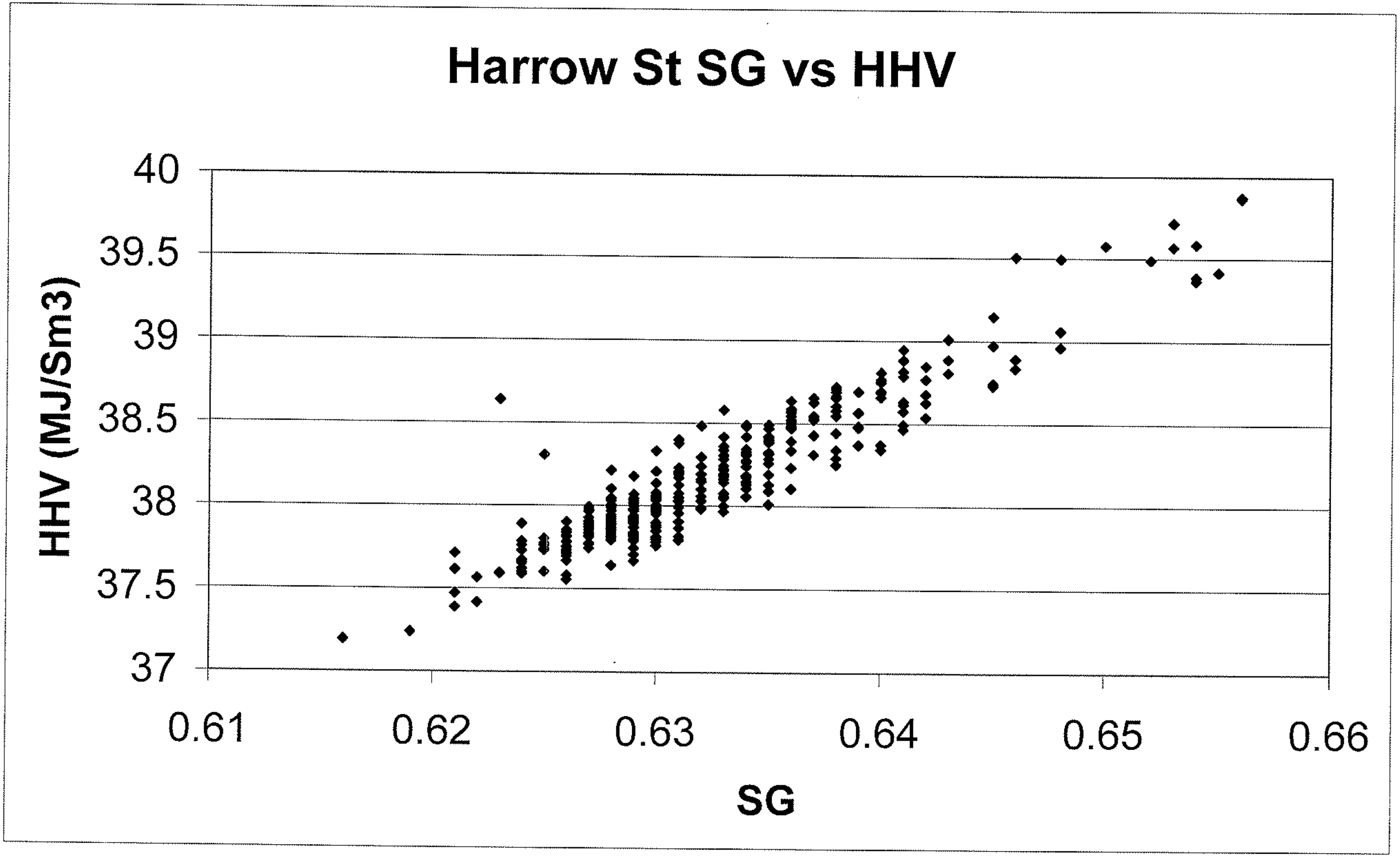
The final selection will depend on the priority AGN assigns to each of these factors.

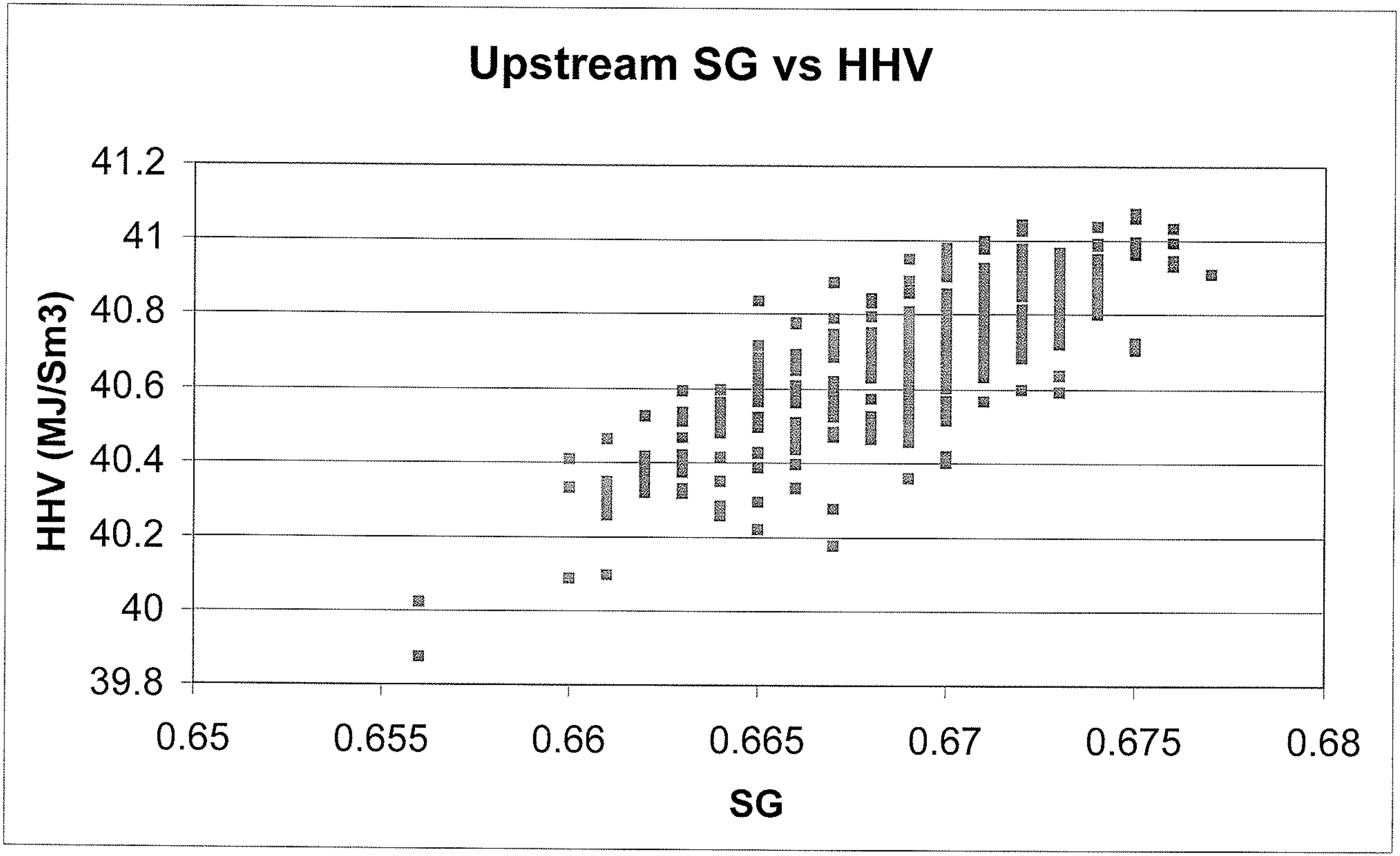
# Appendix A
## HHV Correlations

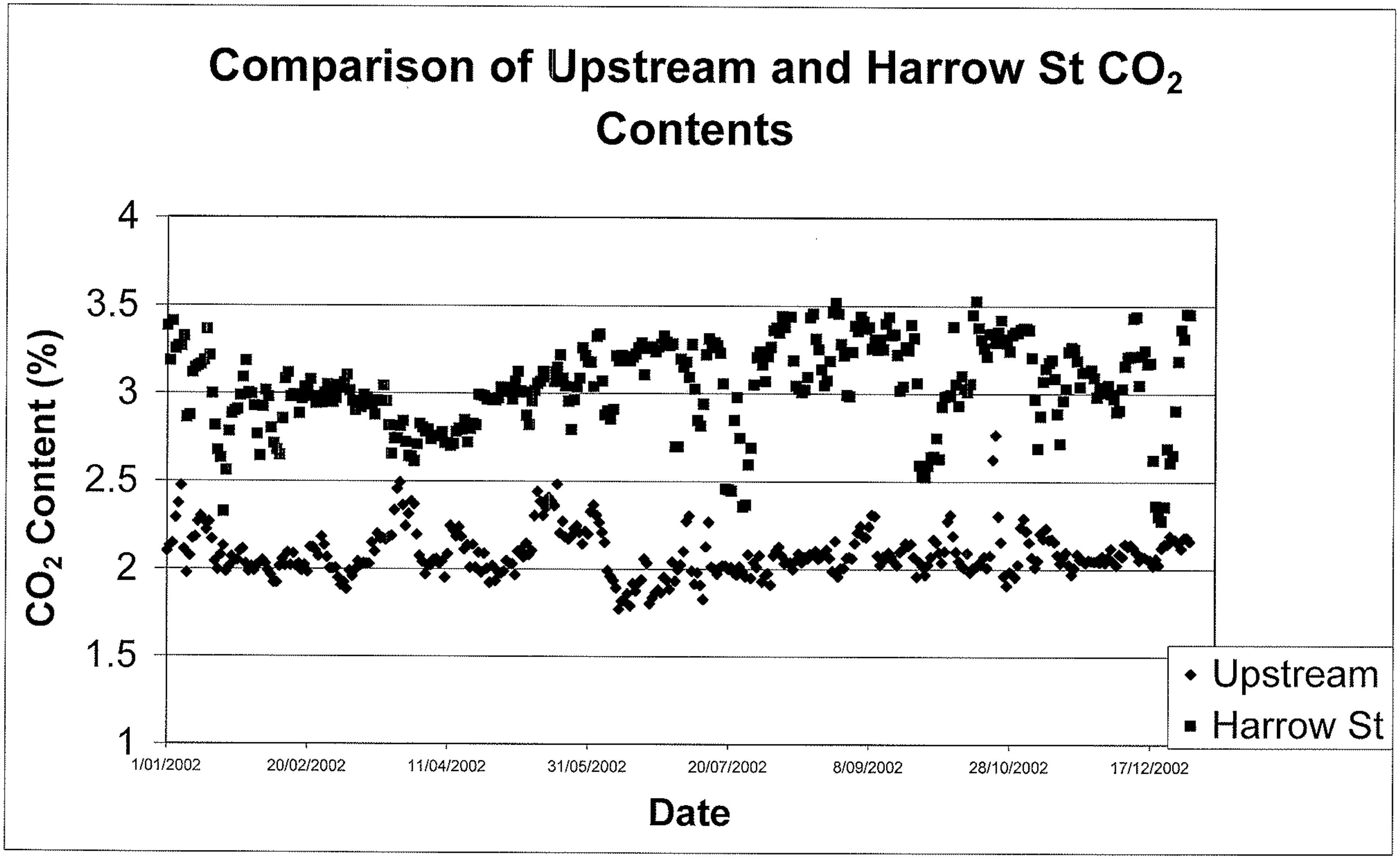

Correlation between Harrow St CO2 Content and HHV
HHV (MJ/Sm3)
40.5
40
39.5
39
38.5
38
37.5
37
2
2.5
3
3.5
4
CO2 Content (%)

## Upstream Correlation Between CO2 Content and HHV

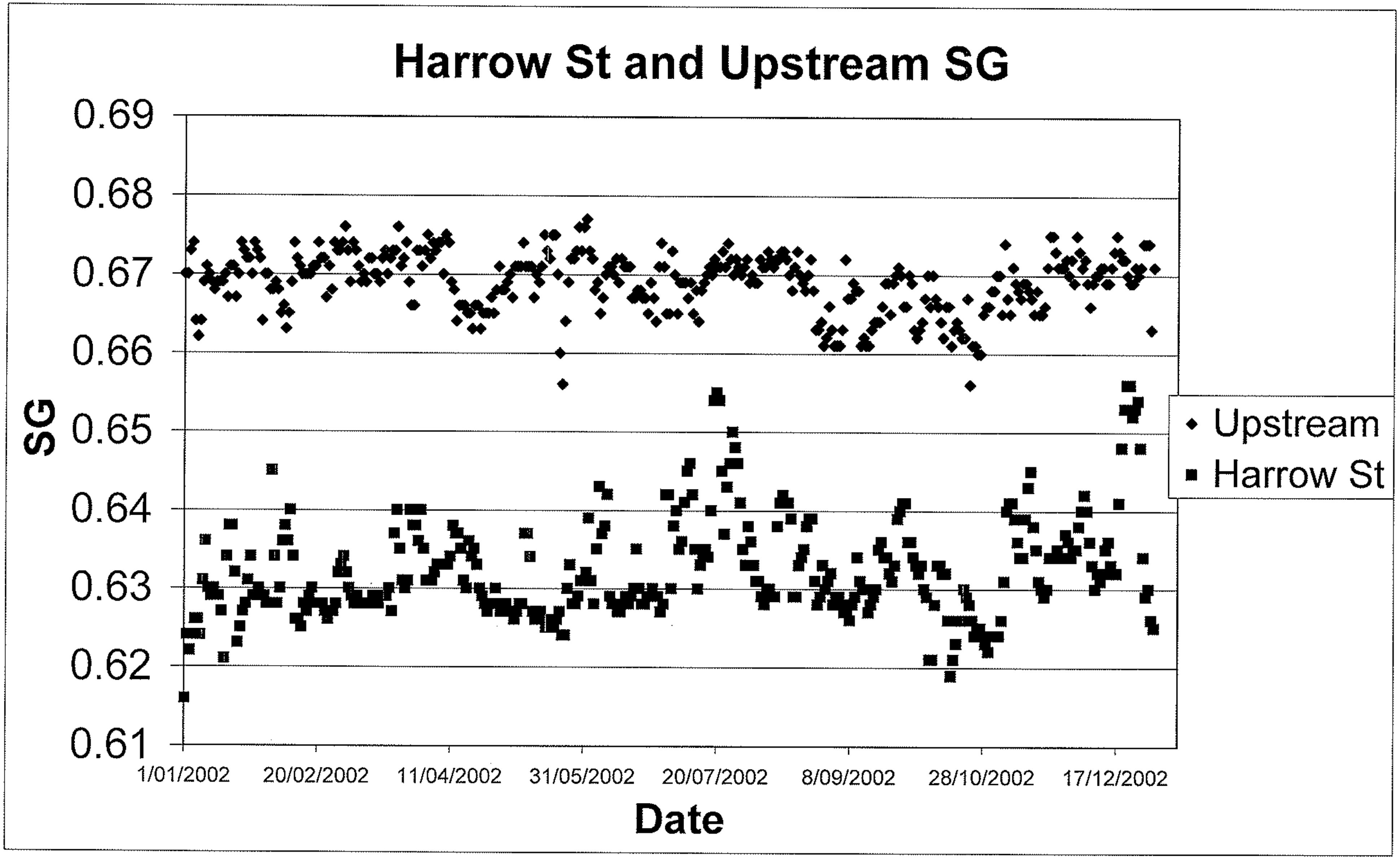


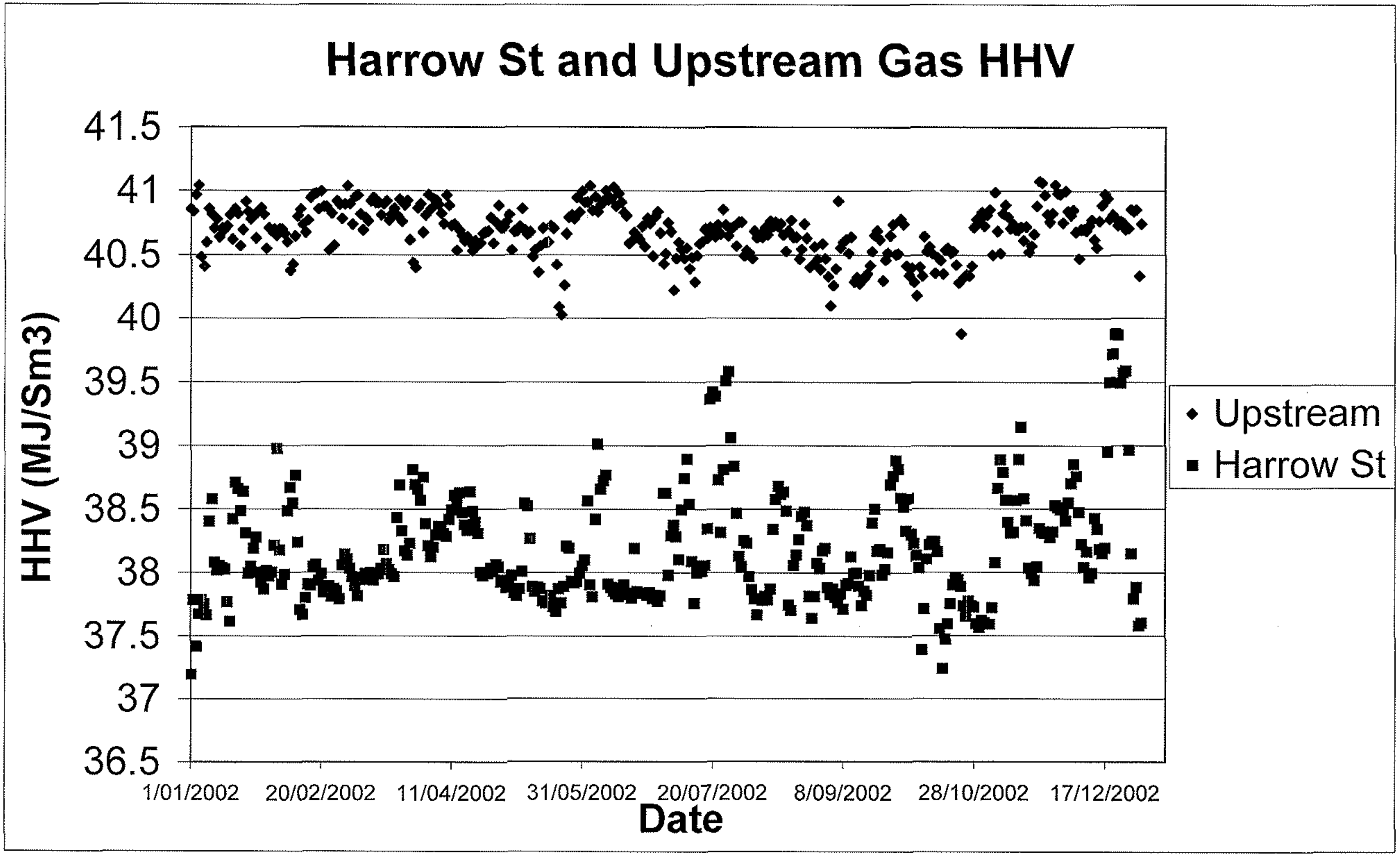

Harrow St SG vs HHV
HHV (MJ/Sm3)
40
39.5
39
38.5
38
37.5
37
0.61
0.62
0.63
0.64
0.65
0.66
SG

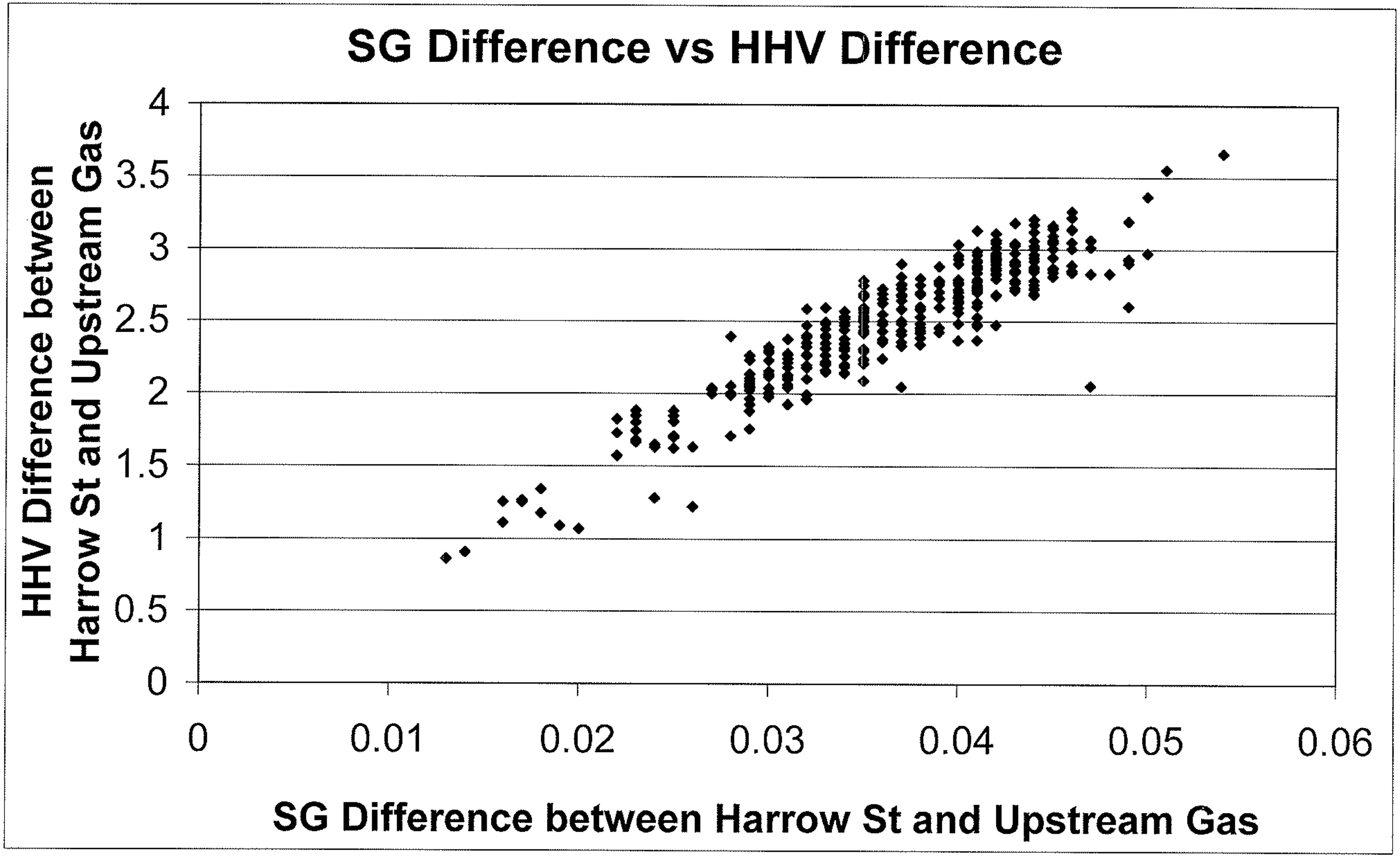

Upstream SG vs HHV
HHV (MJ/Sm3)
41.2
41
40.8
40.6
40.4
40.2
40
39.8
0.65
0.655
0.66
0.665
0.67
0.675
0.68
SG



Comparison of Upstream and Harrow St CO2 Contents
CO2 Content (%)
4
3.5
3
2.5
2
1.5
1
1/01/2002
20/02/2002
11/04/2002
31/05/2002
20/07/2002
8/09/2002
28/10/2002
17/12/2002
Date
Upstream
Harrow St


Harrow St and Upstream SG
SG
0.69
0.68
0.67
0.66
0.65
0.64
0.63
0.62
0.61
1/01/2002
20/02/2002
11/04/2002
31/05/2002
20/07/2002
8/09/2002
28/10/2002
17/12/2002
Date
Upstream
Harrow St


Harrow St and Upstream Gas HHV
41.5
41
40.5
40
39.5
39
38.5
38
37.5
37
36.5
HHV (MJ/Sm3)
1/01/2002
20/02/2002
11/04/2002
31/05/2002
20/07/2002
8/09/2002
28/10/2002
17/12/2002
Date
Upstream
Harrow St


SG Difference vs HHV Difference
HHV Difference between Harrow St and Upstream Gas
SG Difference between Harrow St and Upstream Gas
0
0.5
1
1.5
2
2.5
3
3.5
4
0
0.01
0.02
0.03
0.04
0.05
0.06