



CSols  
laboratory systems integration

Justification for the deployment of CSols  
Remote Sampler™ for field data  
capture and sample collection

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# Justification for the deployment of CSols Remote Sampler™ for field data capture and sample collection

## EXECUTIVE SUMMARY

The improvements in productivity and quality that are possible by deploying the Remote Sampler integrated mobile computing based field data capture and sample collection system instead of a paper based workflow are quite considerable and include the following highlights for organisations who are performing routine sampling:

- **25% Increase in effective sampling time**

By reducing non-productive administration activities like LIMS sample registration, the samplers effective sampling day can be increased by 25%. This extra capacity can be used to eliminate sampling shortfalls or to increase sampling frequency at key assets and sites.

- **Real time assignment eliminates wasted journeys**

Having the option of interactively assigning and then dynamically re-assigning collection during normal working hours while samplers are in the field can eliminate wasted journeys and improve actual sampling frequency by an estimated 5% to 10%.

- **17% Reduction in mileage**

Optimising daily collection routes leads to a reduction in fleet mileage of up to 17%<sup>1</sup> with an equivalent 17% time saving<sup>2</sup>.

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<sup>1</sup> Taken from *Improved Performance through Optimisation*, ALK Technologies, June 2014.

<sup>2</sup> Based on 30,000 miles per sampler per year at £0.30 per mile (Total fuel cost of £270,000)

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## Improvement Summary

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## Introduction

While the companion document '**Extending the Reach of LIMS Through Remote Data Collection**' provides readers with a technical explanation of how a **Remote Sampler** system can be used by water utilities companies and environmental contractors to meet their respective national and international legal obligations for water quality monitoring, this document is designed to discuss in detail those potential financial and quality savings which would be possible should a **Remote Sampler** system be deployed.

### Remote Sampler vs paper-based systems

The remit of this White Paper is to compare and contrast the benefits of deploying **Remote Sampler** into a sampling workforce which has been using paper based worksheets and schedules coupled with manual entry of recorded data into a laboratory management systems (LIMS). Clearly in some cases other electronic systems may have been implemented, however we hope that the comparisons made here can be used in different circumstances.

During its preparation evidence was gathered from a range of sources including existing **Remote Sampler** users. Clearly a number of assumptions have been made, however all references and calculations are described and findings have been judged realistic with experienced users.

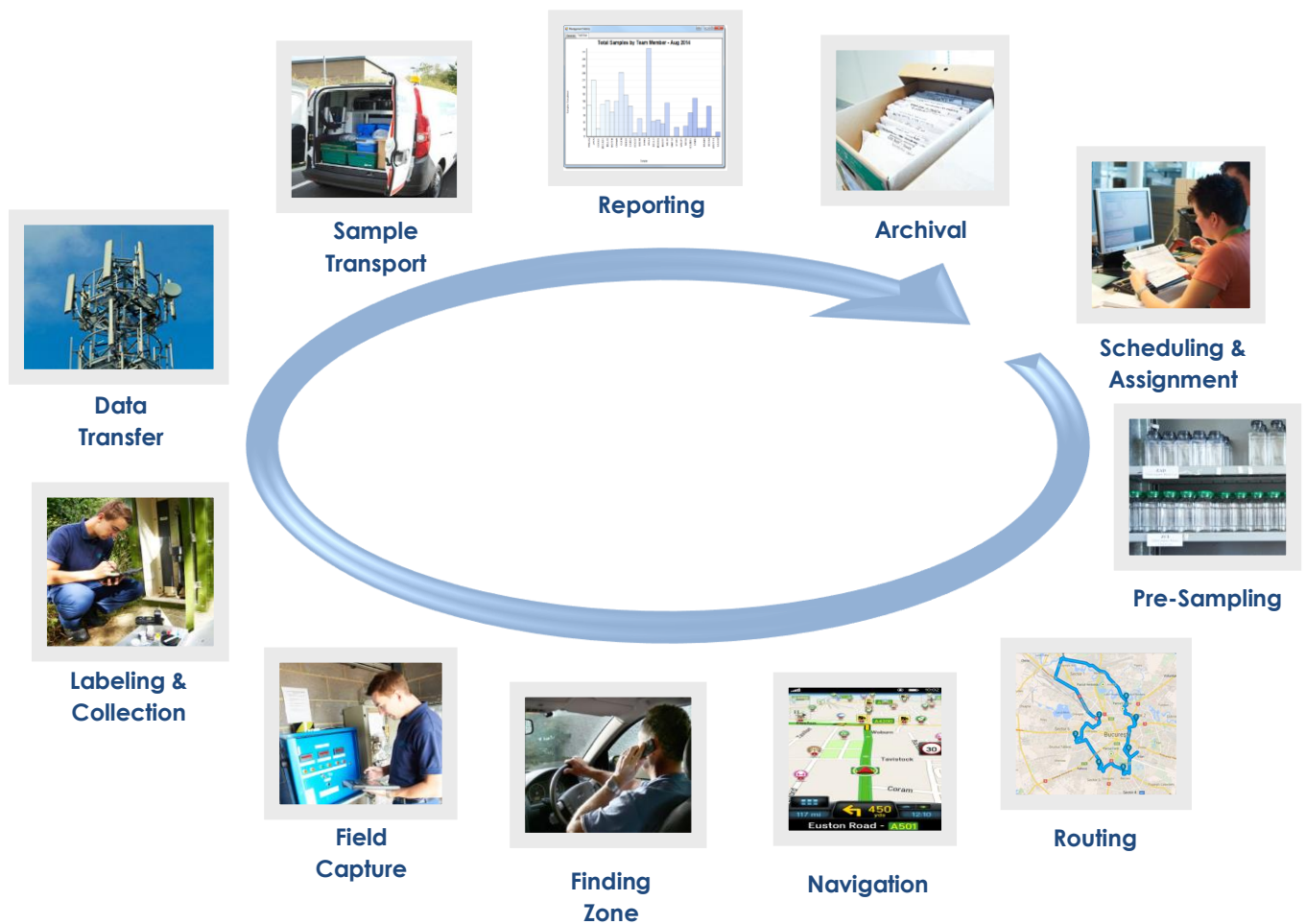
Improvements in overall quality created by a more robust and 'simpler to use' system, where all data is collected into a cohesive and accessible custody trail, are of course more difficult to quantify. However, it is clear that sampling and transcription errors, and a poor audit from a regulator will require a good deal of unplanned effort to address, quickly justifying an investment cost.



## Systems Analysis

The deployment and usage of **Remote Sampler** system will of course vary from organisation to organisation. However, to help articulate and quantify the improvements possible we first performed a simple systems analysis to describe the operational steps used by a typical sampling workforce (see below). The savings were then described either in the form of 'time in minutes saved' by a sampler, or where this was not possible in terms of simple cost saving. The time savings were then grouped together and translated into financial savings using typical salaries. See table later. Quality improvements are also described where appropriate.

Each of the operational steps are presented here in the diagram below. Work flows clockwise starting with *Scheduling* and ending with *Archival*. Benefits provided by better reporting and reduced paperwork are also covered.



## 1. Scheduling & Assignment



While the annual sampling quota for clean and waste water samples is carefully scheduled in advance (often done by a LIMS or resource planning system), day-to-day variations in sampling resources often interrupt the smooth running of the sampling teams. This may be due to van breakdowns, staff sickness, unplanned absences, bad weather, road works, traffic jams, unplanned plant maintenance, plant breakdowns, pipe bursts or other emergencies.

### Workflow

The **Remote Sampler Hub** desktop software, operated at sampling depots or laboratories by sampling managers, planners or team leaders, provides a layer of separation between the annual schedule and the sampling team. The **Hub** also gives a real-time view of assigned daily/weekly schedules (collection runs) and allows the sampling manager to interactively adjust, reschedule and redeploy samplers to account for disruptions. Re-allocation can be done in advance (e.g. one week ahead), each day before samplers set off, or instantly *on-the-fly* during the day using wireless communication.

### Time and cost savings

Time and resource savings are made through:

- **Dynamically reallocating work**  
Reallocating all or part of a schedule to other samplers electronically rather than adjusting paper sheets when a sampler is sick or absent.
- **Dynamically splitting active collection runs**  
Redirecting samplers when road works, emergency, van breakdown or plant failure will not allow sampling at specific locations that day.
- **Creating ad hoc samples**  
Adding new ad hoc or emergency or last minute sampling requests and passing them directly to the samplers already in the field.

We estimate that collectively, 5%-10% of all sampling events are missed and must be rescheduled. In order to get back on target these collections must then be made up at weekends or bank holidays incurring overtime payments and associated costs (fuel and lab time). Saving will also be made in the actual re-assignment process.

### Quality Improvement

A simpler and audited mechanism for the re-assignment process which can be used by all staff members will provide improvements in quality and traceability.

## 2. Pre-Sampling Preparation



Once a schedule has been transferred to each sampler, they can prepare to start their scheduled work. With many different bottle types per sample for multiple sites visited per day (average 15), the sampler needs to be sure they have sufficient available empty bottle stocks. In addition, if field measurements are being made, instruments and equipment must be checked and calibrated. Vehicle checks are also mandated to meet Health and Safety requirements.

### Workflow

The **Remote Sampler Mobile** software has been equipped with a number of secondary workflow features to assist the sampler during this step, which is often currently carried out using separate paper records. Time and resource savings will be made through:

- **Empty bottle stock check**

Remote Sampler Mobile maintains a record of the number of bottles/containers needed for each schedule so that a sampler can check whether they have sufficient stock in their vehicle to ensure all planned samples can be collected correctly.

- **Daily & Weekly Vehicle**

The sampler can use Remote Sampler Mobile to electronically record all the necessary information to speed up and maintain records of all these checks.

- **Test equipment, calibration & AQC checks**

Check lists can also incorporate all test equipment and any calibration or AQC reagents required. Calibration or AQC results carried out are also recorded.

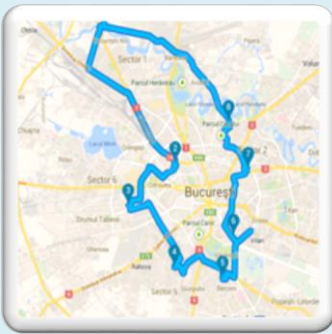
### Time and cost saving

While modest time savings can be made in this way, they do free up a valuable percentage of productive sampling time for each sampler. Evidence suggests that at least 5 minutes of each day per sampler can be saved.

### Quality Improvement

Again, a single integrated and (prescribed) simpler process where all data and equipment information is included in the custody trail leads to improved quality.

### 3. Route Planning



With a number of sample sites to visit each day, if one or more of the locations are not familiar, samplers may use a satellite navigation system to guide them. However, its likely many schedules will be familiar to experienced samplers unless randomised zone samples are included in their schedule.

#### Workflow

When **Remote Sampler Hub** downloads a detailed set of sample data to each sampler's mobile device, it includes the co-ordinates of each sampling location (e.g. the northings & eastings). These co-ordinates can be used to optimise the route taken between the sampler's current location (home or depot) and all of the individual locations (also called multi-stop route optimisation).

#### Time and cost saving

Multi-stop route optimisation like this can lead to a reduction in fleet mileage of up to **17%**<sup>3</sup>. At the fuel prices at the time of writing, this could equate to a fuel cost saving of £1,530 per sampler per year<sup>4</sup>. On the assumption that there would also be 17% less miles travelled then the samplers will also spend 17% less time travelling (or 50 minutes per day per sampler assuming a 5-hour sampling day).

Area	Num
X Belford High nu109342	1
X Blakelaw Road	2
X Elford nu188312	1
X Glorum nu169335	1
X Harlaw Hill SR Combined	1
X Stoneyhills nu184123	1
X Wandylaw SR Outlet 1 and 2	1
X West Swansfield Reservoirs	1
X Whinney Hill nu218203	1

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**A schedule displayed on Remote Sampler Mobile, before and after optimisation.**

#### Quality Improvement

No specific quality improvement realised here.

<sup>3</sup> Taken from *Improved Performance through Optimisation*, ALK Technologies, June 2014.

<sup>4</sup> Based on 30K miles per sampler per year at £0.30 per mile. (Total fuel cost of £270,000)



## 4. Navigation



The members of the sampling team have to find their way to a selection of locations including service reservoirs, water treatment works, customer addresses and corporate trade clients. Locating a customer address can be difficult, doubly so for new team members who may not know their sampling area well. Time spent finding an address is productive sampling time that is lost from the day.

### Workflow

The **Remote Sampler** mobile device app is integrated with CoPilot® satellite navigation software from ALK Technologies. This provides turn-by-turn navigation to each location and could also provide traffic updates and alternative routes. As **Remote Sampler** already has all the sampling locations for each schedule the sampler doesn't have to waste time entering any further location information into CoPilot®. The live traffic and route information also provides additional benefit.

### Time and cost savings

Compared then to the use of a hardcopy list of locations and manual entry into a standalone Sat Nav system at each location, it is estimated there will be savings of approximately 15 minutes per day per sampler.<sup>5</sup>

### Quality Improvement

No specific improvement in quality here. Please note though that individual organisations have specific guidelines on the use of Sat Nav system in vehicles which may prevent the use of CoPilot® in this way.



<sup>5</sup> Assume 15-20 sampling locations per day and 1 min per location saved

## 5. Finding Zone Address



To prove water quality between water supply source and consumers, all water utilities must undertake regular randomised sampling from consumers. Organised by supply zone, random sampling can make up around 10% of all clean water sampling. Randomisation of the addresses selected is usually done by LIMS or resource planning software.

### Workflow

When collecting water samples from randomised addresses, the **Remote Sampler** mobile device app offers strategies in the event that no sampling can occur at the original target address. This strategy provides the sampler with immediate authorised address alternative and saves time on phone calls to the sampling manager or customer services, and so increases the samplers effective sampling day. Flagging of blacklisted or vulnerable addresses also reduces wasted time and reduces health and safety risks.

### Time and cost savings

Assuming that a sampler is not able to sample at one address per day that would save 5 minutes searching for alternative addresses or getting guidance. The indirect benefit of zone sampling of course is the opportunity for the sampler to interact directly with customers perhaps sharing information or topical consumer advice available on the mobile device.

### Quality Improvement

Finding alternative addresses must follow the prescribed process and any 'no sample' event is recorded with comments and/or photographs to ensure a full custody trail is maintained.



## 6. Field Data Capture



Visits to regulated sample points are opportunities not only to perform compliance sampling but also to record operational data about that location which cannot be obtained from telemetry systems. At unmanned assets like water treatment works or reservoirs, samplers may be the only regular visitor and are able to perform a range of field measurements that are important to pick up spills or plant malfunctions that can be addressed while the sampler is still in the vicinity.

### Workflow

The **Remote Sampler** mobile device app offers the capability of recording information using easy to follow data entry screens, whatever field conditions (outside, out of signal, underground etc.) Each field prompt is designed to follow existing procedures and is dynamically validated to both guide the user in perhaps challenging conditions and ensure valid entries are recorded.

### Time and cost savings

Using electronic input in this way obviously saves time and eliminates transcription errors compared to using paper based systems (errors occur in **20%-40%** of cases where paper forms are copied <sup>6,7</sup>). However, with the combination of the larger screen, wizard operation and ability to record associated photographs with samples, the **Remote Sampler** mobile device app makes data entry a much more attractive option for recording data compared to smaller format phone based systems.

The impact of being able to more effectively capture useful data may mean that data entry increases the sampler's duties rather than decrease them. So, we would estimate that this task would take on average 5 minutes longer per sample point than with a conventional paperwork system. As before is it difficult to quantify all of the potential saving but anecdotal evidence has highlighted several examples where timely action would have saved considerable expense and/or fines.

### Quality Improvement

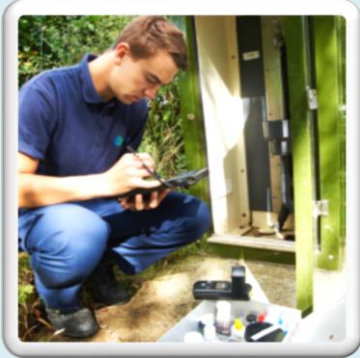
Using a prescribed process to record data in this way has a significant impact upon data quality and the ability to use it to prove a custody trail and so benefit the organisation.

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<sup>6</sup> E. Cole *et al*, A comparative study of mobile electronic data entry systems for clinical trials data collection, *International Journal of Medical Informatics*, 2005

<sup>7</sup> M. Khoury *et al*, Error Rates In Australian Pathology Laboratories, *Med J Aust*. 1996 Aug 5;165(3):128-30

## 7. Labelling & Collecting Bottles



Once a sampler has reached each targeted sampling point, the process of taking samples can begin. The sampler will use a selection of equipment to ensure a representative sample is taken using the correct bottles and that a number of field measurements are taken.

### Workflow

As with field data capture, the **Remote Sampler** mobile device app also guides each sampler through the sampling process and fully supports the reading of barcode encoded labels to both verify the sampling location, and to read labels affixed to filled bottles. Entering data via barcode is much faster and far less error-prone than manually recording bottle numbers on paper or entering information using a keyboard. Any sampling exception (e.g. bottle broken, tap unusable, site inaccessible) can also be recorded during processing and once complete provides an updated status on the day's sampling.

### Time and cost savings

While barcode input is convenient compared to manual entry, experience suggests that **Remote Sampler** offers few net overall time savings during sampling. The main improvements are convenience and less risk of incorrect assignment and transcription. In the case of waste water samples, the **Remote Sampler** mobile device app provides additional support to guide the often more complex sampling process. (e.g. with in-built timers and use of the device camera). Hence the savings in time are likely to be more considerable and may increase to 10 minutes per sample.

### Quality Improvement

Tight control of the sampling process with recording of the time and position of sampling with positive readings of bottle ids gives a very robust custody trail which provides proof of sampling to satisfy all regulators.

## 8. Data Transmission to the Laboratory



Once collected, information about samples is usually entered into one or more LIMS or host IT system(s). When a paper-based solution is used, worksheets are taken back to a depot or to the laboratory where the samplers themselves, or laboratory staff perform manual data entry.

### Workflow

Unlike paper systems, the **Remote Sampler** solution allows all data to be returned electronically to LIMS or other back-end data-systems immediately as soon as each sampling event is completed. This means that not only do all the sampling team leaders get near real-time information about the sampler and their location, but there is no need for the sampler to do any further data entry or transcription. **Remote Sampler** also allows for changes or additions to the sampler's current schedule to be received by the sampler's device continuously, hence enabling the re-allocation benefits described earlier.

### Time and cost savings

By far the biggest saving achieved by enabling data transmission and LIMS connection in this way is automatic sample registration/reception. This means that not only do samplers have more time for sampling but they don't need space to sit in the depot or laboratory, nor need a licence to access the LIMS system directly. As it can take a sampler 15 minutes or more to manually enter the data for a single schedule and the associated travel time required to reach the depot, there will be saving of at least one hour of active sampling per sampler per week.

### Quality Improvement

The elimination of transcription errors due to manual entry by samplers or laboratory staff makes a substantial improvement to quality.

## 9. Sample Transportation & Logistics



The journey that sample bottles take back to the laboratory may vary depending upon the geography and sample type. For larger regions, samplers may be based at strategically placed depots and bottles may be returned there for onward collection to one or more laboratories by courier. Alternatively, samples may be left at the original location in a refrigerator for collection or at a pre-agreed courier pick up locations. Different sample types may also follow different journeys as they cannot travel together in the same vehicle.

### Workflow

It is essential to maintain the integrity of the sample custody trail throughout transportation and so **Remote Sampler** provides a range of functions to support the recording of bottle transfers between sampling vans and/or internal or external couriers.

### Time and cost savings

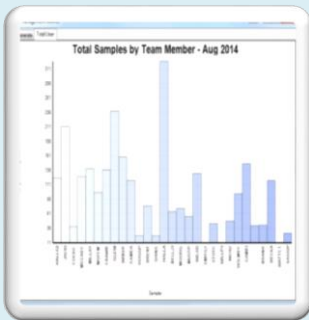
There is little difference in effort expended compared to doing transfers with Remote Sampler Mobile and conventional paperwork systems. However, as with delivery of goods, the custody trail provides a clear record of bottle history and should prevent the loss of bottles and any dispute about sample location.

### Quality Improvement

Maintaining an auditable custody trail between sampling point and the testing laboratory provides a key quality improvement compared to a paper based system.



## 10. Reporting and Auditing



Typically, there are two reporting requirements of a routine sampling operation. These are to monitor the day-to-day performance of the sampling team using pre-agreed Key Performance Indicators (KPIs), and to generate documentation to support external audit by regulators.

### Workflow

Every action carried out by a sampler during sampling is recorded automatically and independently in an audit trail, which is stored in the **Remote Sampler** database. Reporting from this database provides a quick and convenient way to produce the following reports :

- **Daily or weekly reports**

Daily or weekly reports can include KPIs such as average number of samples collected per sampler per day or average distance travelled per day.

- **Audit reports**

A single sample custody report can show every action run on a sample to provide a vertical audit report.

### Time and cost savings

It is difficult to quantify the absolute savings made through the ability to access collection data in this way. However, when comparing the effort required to run these reports manually without a database the savings are likely to be substantial. It is estimated that every year a laboratory will invest one man month in running routine compliance reports as well preparing for an audit.

### Quality Improvement

Ready access to audit data gives an external auditor reassurance that the sampling operation is compliant and well managed. Generating KPIs quickly will also help pick up potential issues before they occur.

## 11. Other Indirect Savings



Aside from the day to day process changes in how the sampling team work, the background administration of such a system is also effected.

### Workflow

Customers of **Remote Sampler** report other indirect savings from the implementation of the system. These are related to:

- **New User training**

All workflow screens in Remote Sampler are part of a step-by-step wizard. This reduces the time taken to learn the correct sampling method for each type of sample. GPS route navigation also helps to ease the learning curve. For example, figures from previous implementations using CoPilot® software have shown a reduction in driver training time of up to 90%<sup>8</sup>. If it is assumed that once operational there will be at least one new employee per year and that training can be significantly reduced from two weeks to one week this will save least one man week per year.

- **Minimize archival cost**

All sample data must be stored for six years in order to comply with DWI regulations<sup>9</sup>. Storing 5 years' sampling data on paper with an off-site document storage company costs upwards of **£3,960** a year<sup>10</sup> which would not be necessary.

- **Reductions in paper and ink use**

Removing the need to print collection run sheets, instrument calibration documentation and vehicle check sheets can cost several thousand pounds per year<sup>11</sup>.

<sup>8</sup> Taken from *Improved Performance Through Optimisation*, ALK Technologies, June 2014

<sup>9</sup> [dwi.defra.gov.uk/stakeholders/information-letters/2011/06-2011annexa.pdf](http://dwi.defra.gov.uk/stakeholders/information-letters/2011/06-2011annexa.pdf)

<sup>10</sup> Based on 1 A4 sheet per sample plus daily and weekly checks for 30 samplers over 6 years at £0.50 per archive box per month plus retrieval charges.

<sup>11</sup> Based on paper at 0.7 pence per sheet and printing costs at 2.1 pence per sheet.



## Improvement Summary

In summary, the following savings per sampler per day are possible taking into account the system analysis described above.

Work Step	Impacts	Time Saving	Cost Saving
1) Scheduling & Assignment	Sampler Manager/Sampler	6 mins/day or 10% of sampling *	
2) Pre-Sampling	Sampler	5 mins/day	
3) Route Setting & Optimisation	Sampler	10 mins/day or 17% of sampling *	£1,530
4) Navigation	Sampler	15 mins/day	
5) Finding Zone Address	Sampler	5 mins/day	
6) Field Capture	Sampler	-5 mins/day	
7) Labelling & Filling Bottle - Clean	Sampler	5 mins/day	
OR			
Labelling & Filling Bottle - Waste	Sampler	15 mins/day	
8) Data Transmission	Sampler	15 mins/day	
9) Sample Transport	Sampler	None	
<b>Total (Clean)</b>		<b>71 mins/day</b>	<b>£1,530</b>
<b>Total (Trade)</b>		<b>81 mins/day</b>	<b>£1,530</b>

\* Assuming on average 5 hours of active sampling per day

Also back-office savings are made as follows :

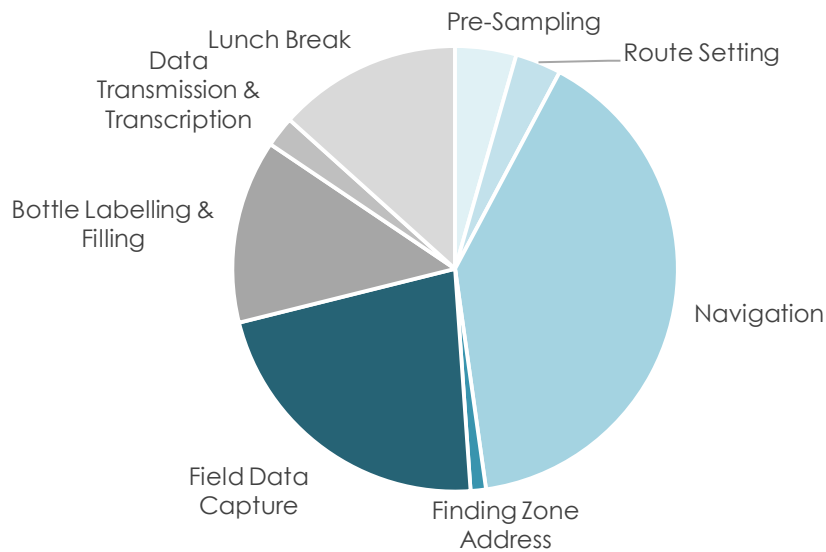
Work Step	Impacts	Time Saving	Cost Saving
10) Reporting & Auditing, Vertical Audits	Quality Manager	1 man month/yr	
11) Other Indirect	Quality Manager		£3,960

Clearly a number of assumptions have been made in compiling this document. However, the significant savings are related to:

- The ability to electronically import an optimised daily route to each hand-held device every morning.
- Improved routing.
- The ability to electronically transmit field results and sampling events back to LIMS.

# Justification for deployment of CSols Remote Sampler™ for field data capture and sampling

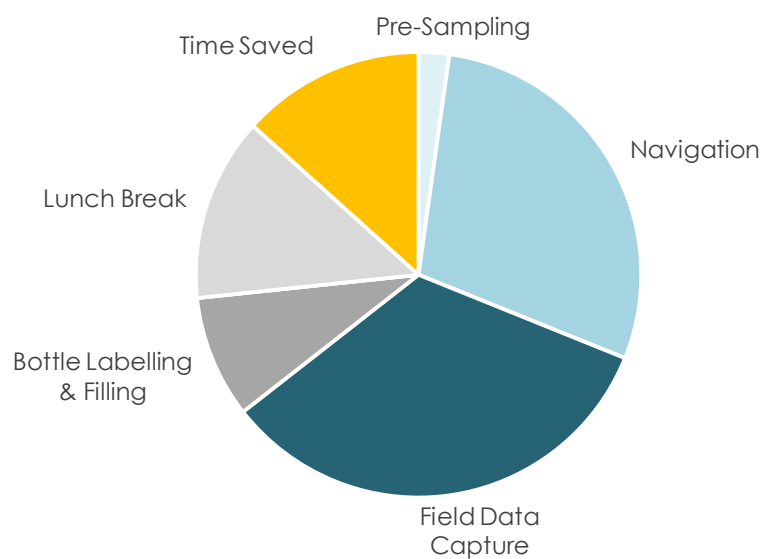
The diagram below illustrates the breakdown of a typical clean water sampling day, from the point of view of a sampler, using a standard paper-based system.



The majority of a working day is split between travel time spent navigating to the sample points and then data and sample collection once there. There are also a variety of shorter tasks that take the sampler several minutes per sample but add up over the day to reduce the sampling efficiency of the sampler.

Following the implementation of **Remote Sampler**, the breakdown of the day changes. With large reductions in the time spent on navigation, coupled with the elimination of many of the other administrative tasks such as planning a route for the day and handling data transmission/input back to LIMS.

The diagram below displays the updated breakdown of a sampling day but this time with the use of **Remote Sampler** to streamline the process.



## Conclusion

**Remote Sampler** automates the non-essential and time consuming steps in the sampling process to free up more time for the sampler to spend on the fundamentals of sample and data collection.

Based on the numbers above we would expect that a typical water company making a capital investment would be able obtain a Return of Investment (ROI) in a **Remote Sampler** system in less than 12 months. Now that Remote Sampler is also available in the form of a Software as a service (SaaS) rental option the savings could be even faster.

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