SEPA
Scottish Environment Protection Agency

Strategic approaches to pollution of water by pharmaceutical substances from… Scotland

By Phil Leeks

Introduction

- Scope of presentation
- Highlight the regulatory regime
- Strategic approaches
- Chemical Investigation Programme in Scotland (Scottish Water & United Kingdom Water Industry Research (UKWIR))
- Conclusion

Scottish Organisations

- Scottish Government
- Scottish Environment Protection Agency
- Scottish Water
- Water Industry Commission Scotland
- NHS Health Scotland
- Veterinary Medicine Directorate
- National Veterinary Service
- Medicines & Healthcare Products Regulatory Agency
- …

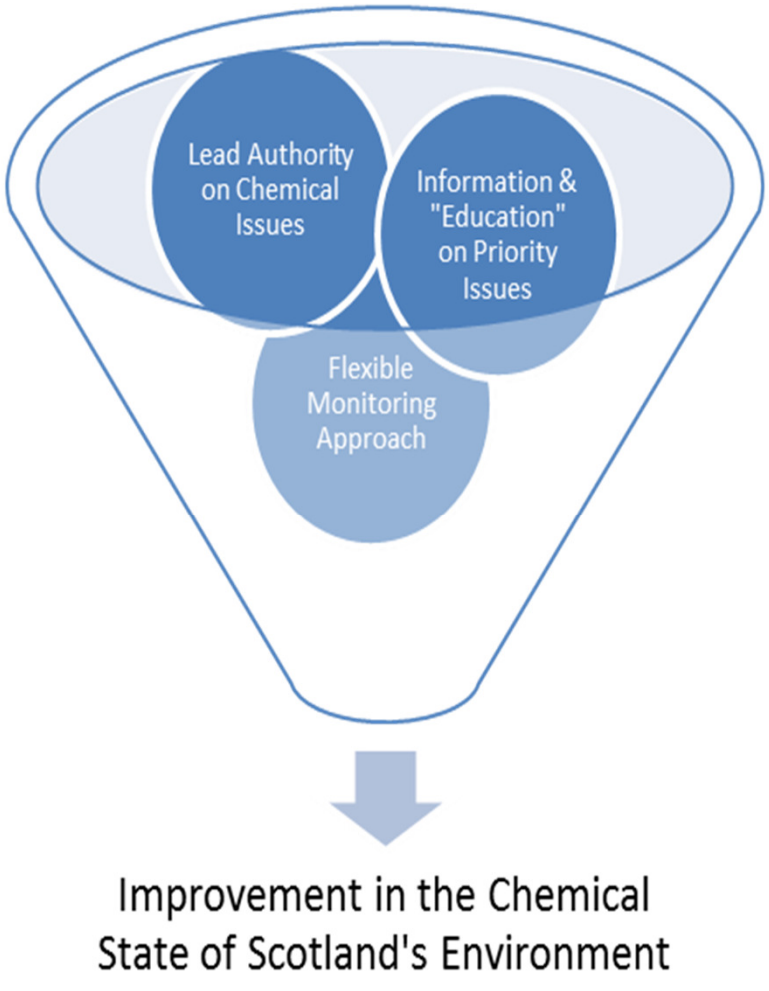
Legislation

- Water Framework Directive 2000/60/EC
- Environmental Quality Standards Directive 2013/39/EU
- Water Environment and Water Services (Scotland) Act 2003
- Water Environment (Controlled Activities) (Scotland) Regulations 2011
- The Scotland River Basin District (Standards) Directions 2014

Strategy

- Scale of concern
  - Where do substance arise
  - Modelling
  - Monitoring
- Attribute source
  - Source apportionment tool
  - Multiple sources
- Mechanisms to achieve objective
  - Identify appropriate mechanism to reduce substance
  - Eliminate at source
  - Break source-pathway-receptor linkages
  - Monitor decline of banned/prohibited substances
- Strategy for prioritisation

Strategy for prioritisation



SEPA Policy

- Established threshold for substances of concern:
  - PS > 2x EQS
  - PHS > 1/10th EQS
- Ability of operator to assess where substances arise from.
  - What is in their system;
  - Where specific substances arise;
  - How these substances can be treated;
  - Are there treatments or what is the cost of treatment.
- SEPA working on Pollution Reduction Plans (PRP's) describe:
  - How substances are produced and used;
  - The source(s) of these substances; and
  - Any known environmental data

Chemical Investigation Programme

In order to deliver obligations under PSD, it was necessary to understand the chemicals of concern, their sources and arisings within the urban catchment, where, if and how they enter the sewerage system.

The Chemical Investigation Programme (CIP) was conceived and promoted initially by the water industry in England & Wales as part of their PR09 investment. Scotland joined this project with SR10 funding. The aim of the project is to fill a knowledge gap.

Collaborators

- UK Water Industry Research (UKWIR)
- Environment Agency (EA)
- Scottish Environment Protection Agency (SEPA)
- 11 water companies
- Ofwat, Defra
- Atkins Ltd
- Brunel University
- Cranfield University
- wca Environment

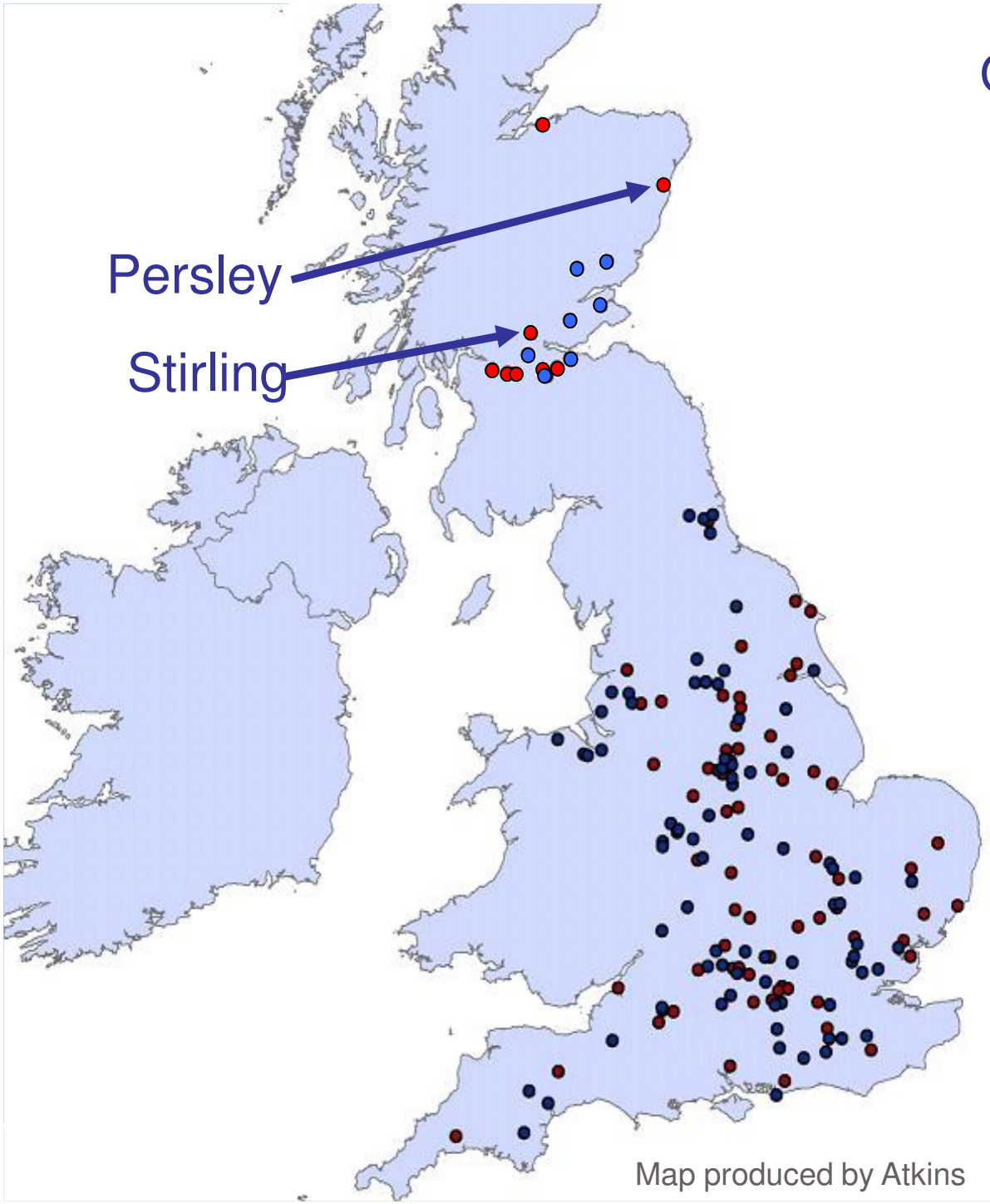
Period Covered: April 2010 to November 2012

CIP - Choice of substances

- Priority substances regulated at EU level
- UK specific pollutants
- Substances of emerging concern (eg pharmaceuticals – including Ibuprofen, Propranolol, diclofenac, salicylic acid)
- Substances to support interpretation (eg BOD, ammonia)

The CIP sampled 162 UK wastewater treatment works.

- C1. Effluent quality at 162 wastewater treatment works;
- C2. Performance (removal efficiency) at 28 treatment works that represent a range of treatment processes; and,
- C3. Investigations of contaminants sources in 9 urban catchments across the UK (ca 1000 samples each).



Map produced by Atkins

Overall UK contribution:

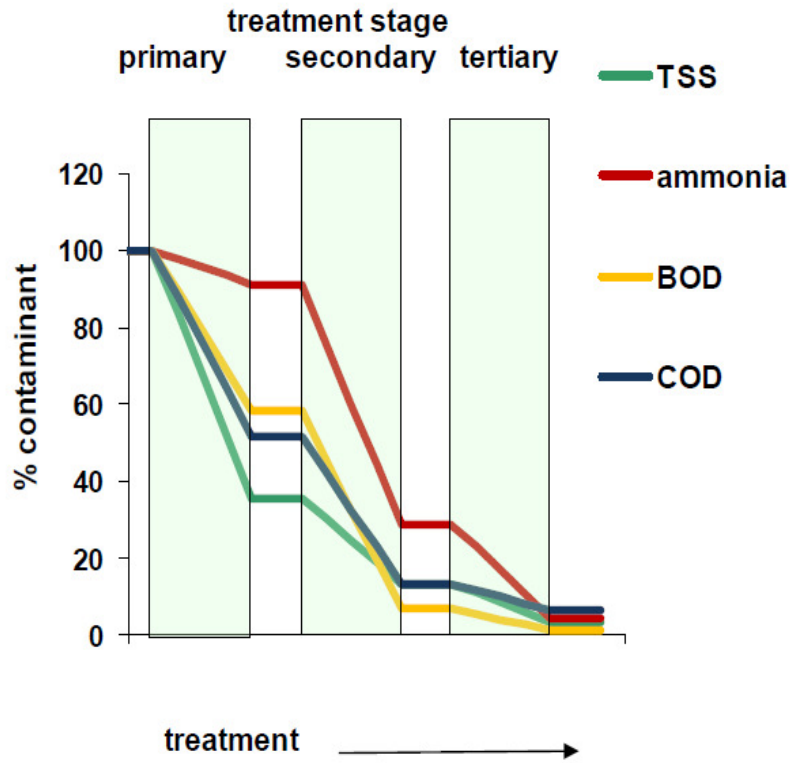
- 162 C1 works
- 28 C2 works
- 9 urban catchment

Red circles indicate sites sampled 28 times in the course of the C1 programme.

Blue circles show sites sampled 14 times.

C2 – Process Investigations

Sanitary determinands

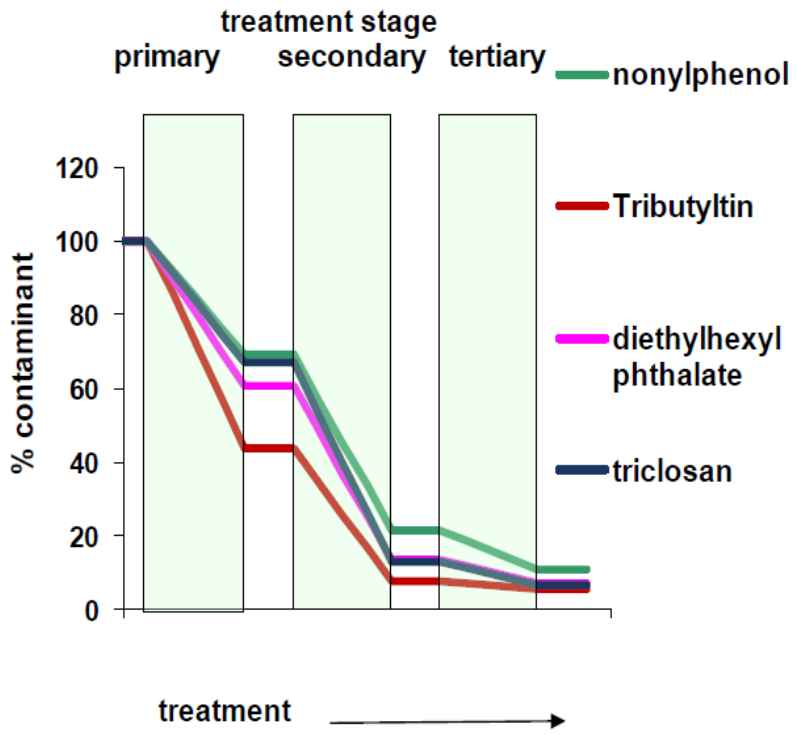


A confirmation that sewage treatment does what it is intended to do.

Predictably, ammonia is shown not to be susceptible to primary settlement, whereas total suspended solids is.

Graph produced by Atkins

Other chemicals of concern

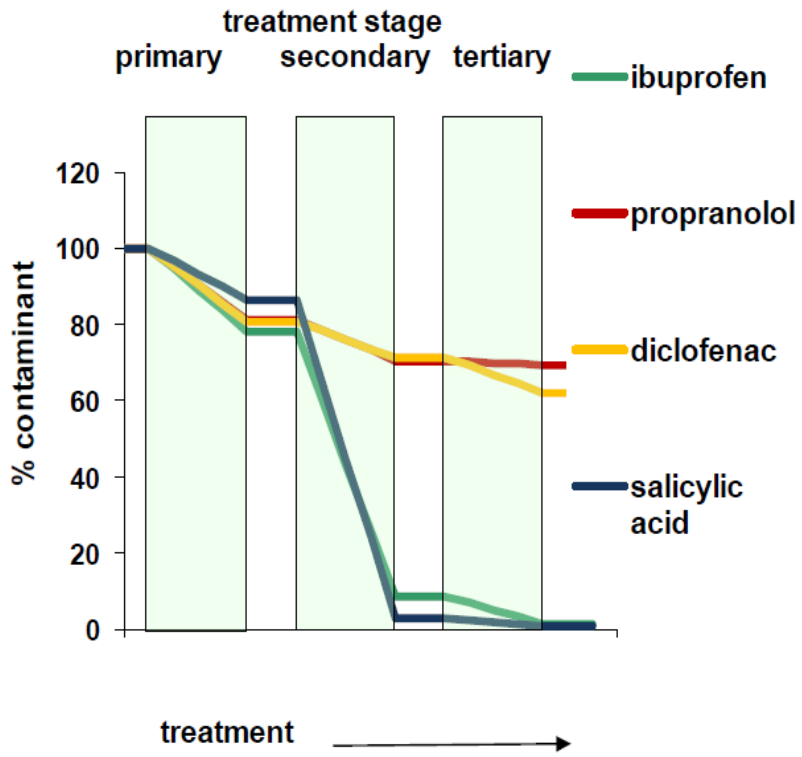


These substances also pose an important compliance risk on account of the relatively low environmental quality standards that have been set. This is, again, despite the impressively high levels of removal achieved in treatment.

Note TBT is more susceptible to removal at the primary stage.

Graph produced by Atkins

Pharmaceuticals

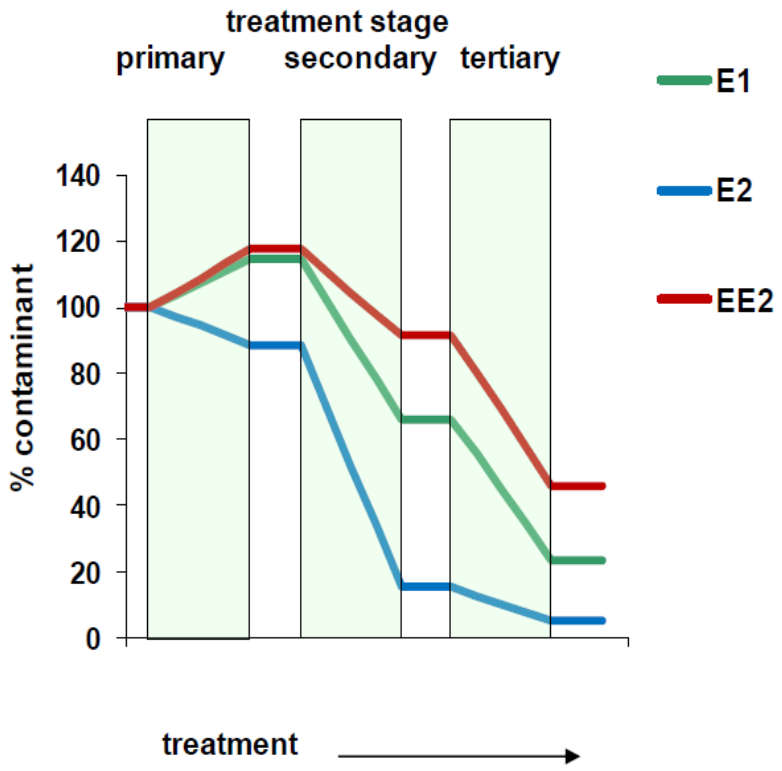


This slide illustrates the principle that some pharmaceuticals are removed effectively, yet others are not. Obviously, this difference relates to their respective chemical reactivities.

Neither group is affected to an important extent by primary treatment.

Graph produced by Atkins

Steroids



An illustration of the well established behaviour of the steroids - E1 and E2 are relatively well removed EE2 less so.

Note: the apparent increases during primary treatment are probably not errors – rather they probably indicate the release of the steroid from conjugated forms that are present in crude sewage.

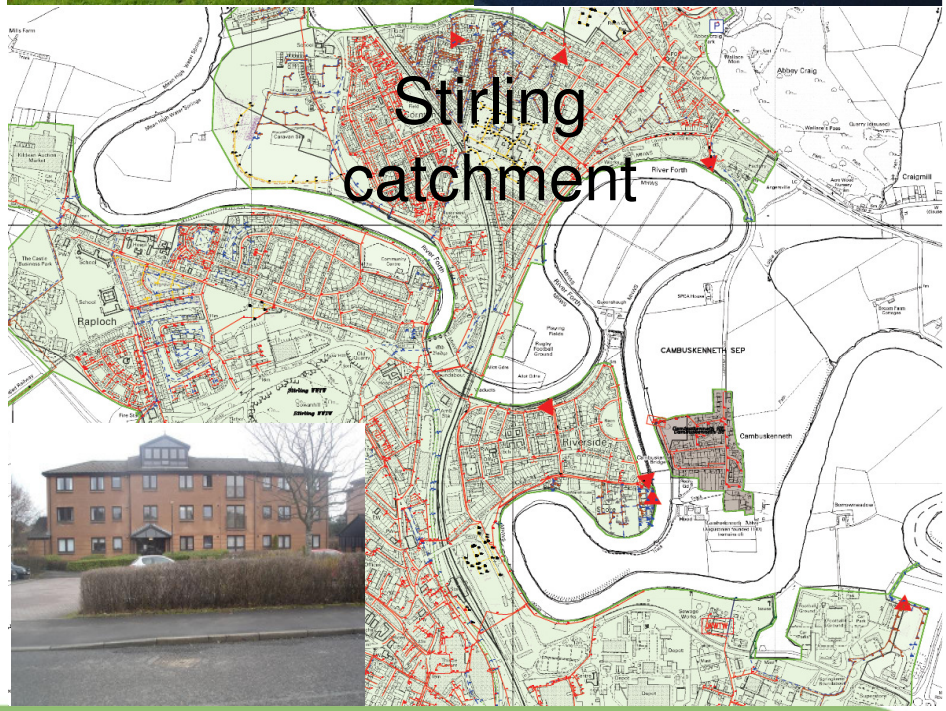
Graph produced by Atkins

SEPA
Scottish Environment Protection Agency

Median fraction removals achieved in conventional treatment using C2 data from all works

Substance	Median % removal
DEHP	95%
Tributyltin	94%
Triclosan	94%
E2	94%
BDEs	90%
Nonylphenol	89%
Copper (dissolved)	67%
PAHs (Fluoranthene)	61%
EE2	54%
Diclofenac	41%
Zinc (dissolved)	20%
Nickel (dissolved)	1%

C3 Catchment Investigations



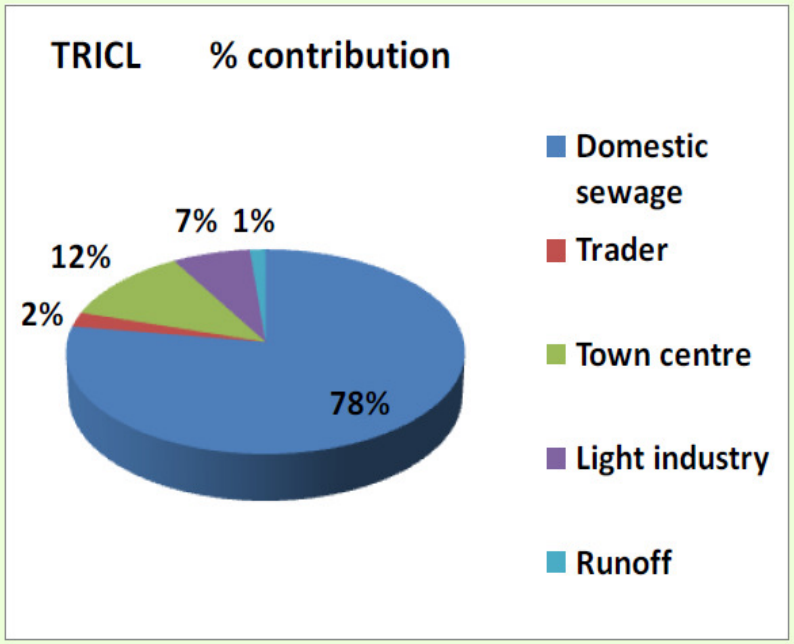
C3a – Urban catchment sampling

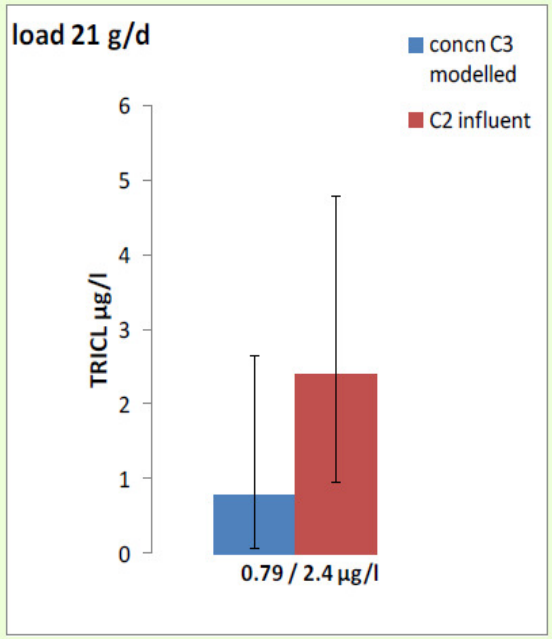
Breakdown of sample numbers for Stirling catchment

Sample type	No. of locations	Sampling occasions	Samples per occasion	No. of samples requested
Domestic sewage	15	12	1	180
Institutional sewage	4	12	1	48
Domestic tap water (cold and hot)	15	4	2	120
Trade Effluent/ Traders	14	24	1	336
Trade Effluent/ Hospitals	2	24	1	48
Town centre	2	12	2	48
Light industry	2	12	2	48
Runoff	4	10	3	120
Total				**948**

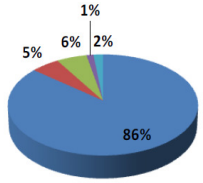
Triclosan

Stirling

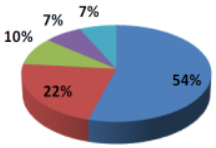




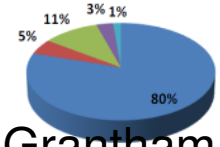
Blackburn



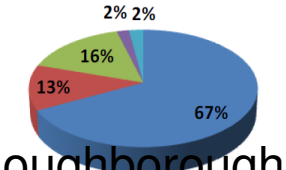
Consett



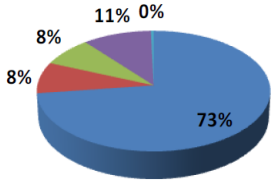
Fazakerley



Grantham



Loughborough

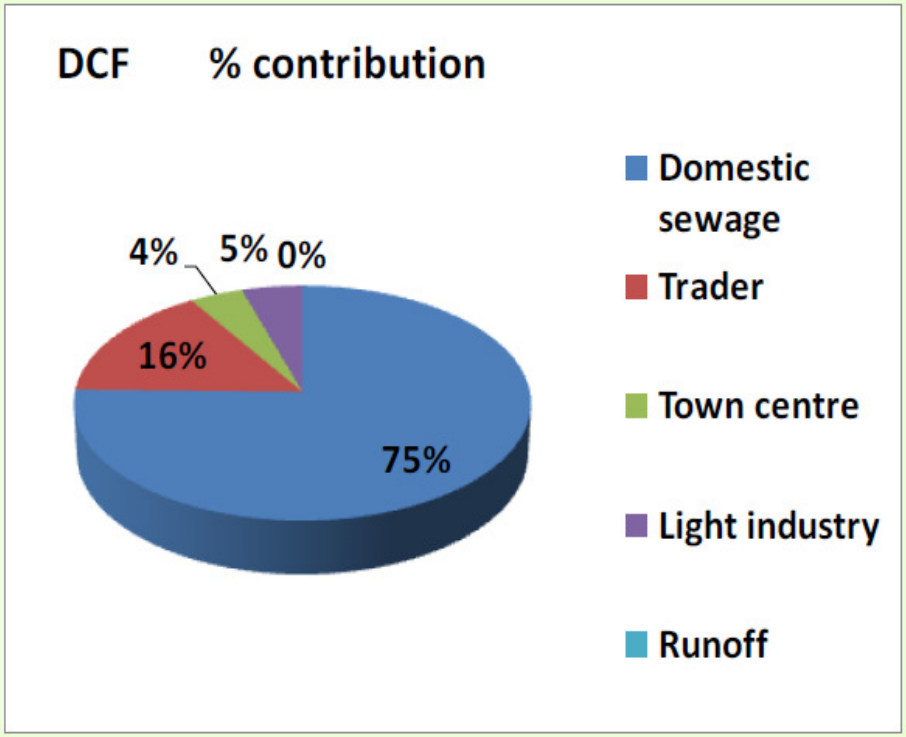


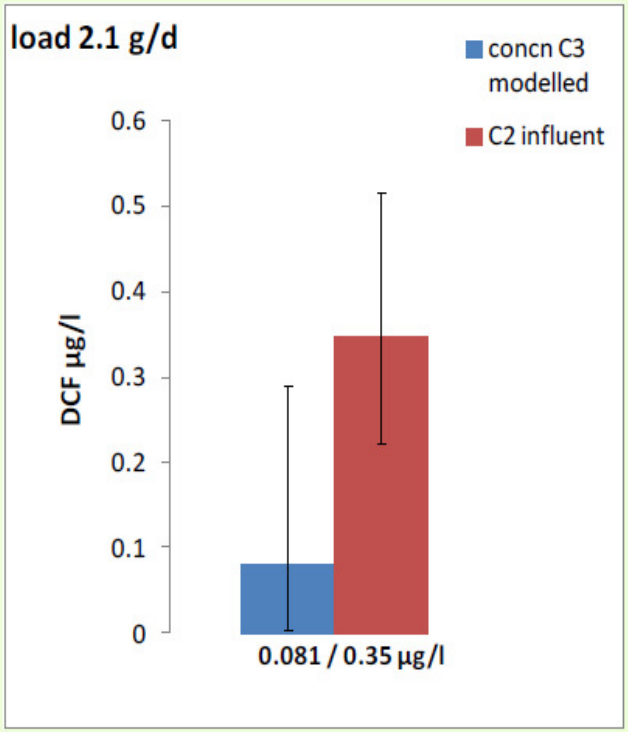
78% of the Triclosan load in Stirling catchment coming from domestic sources.

Graphs produced by Atkins

Stirling

Diclofenac

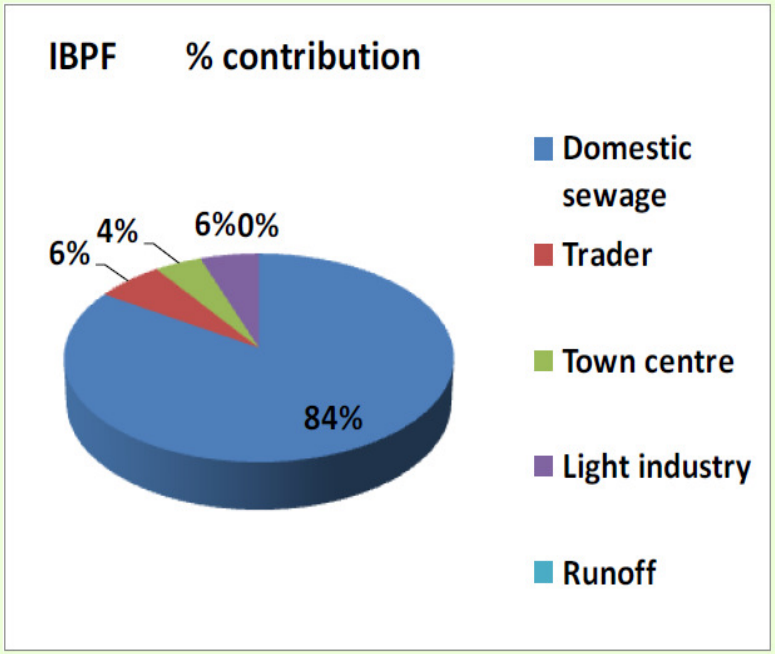


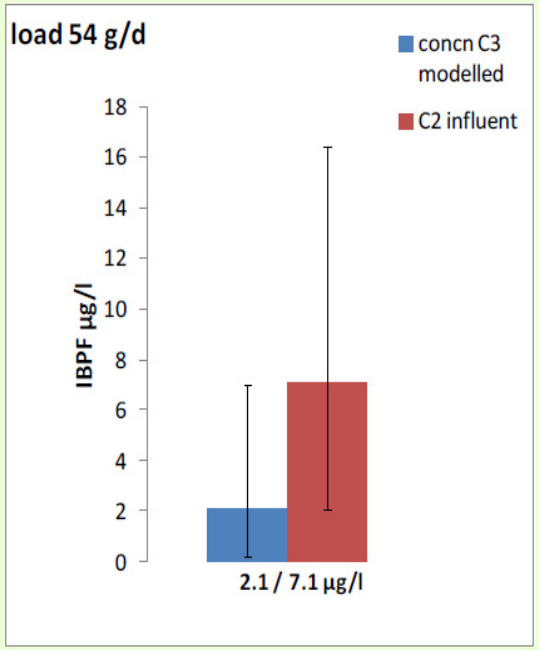


Graphs produced by Atkins

Stirling

Ibuprofen

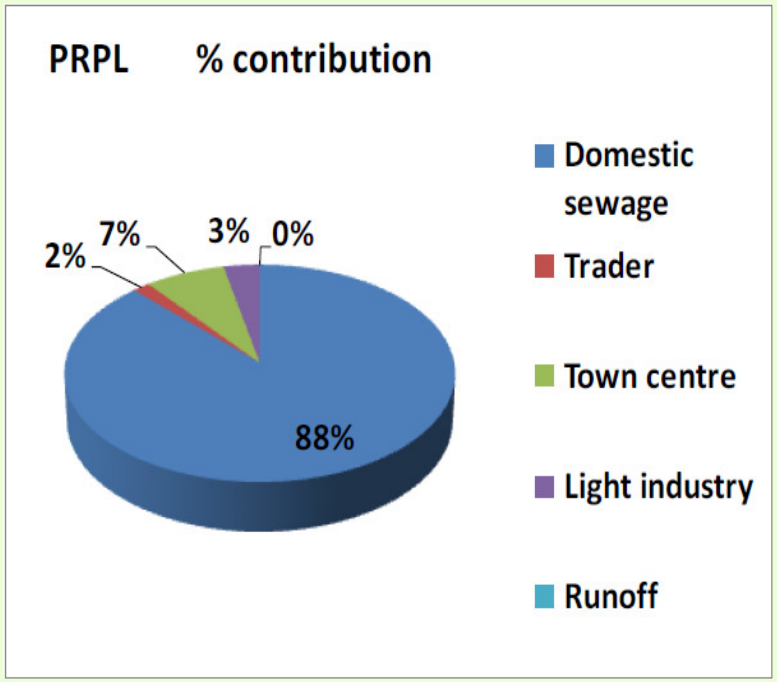


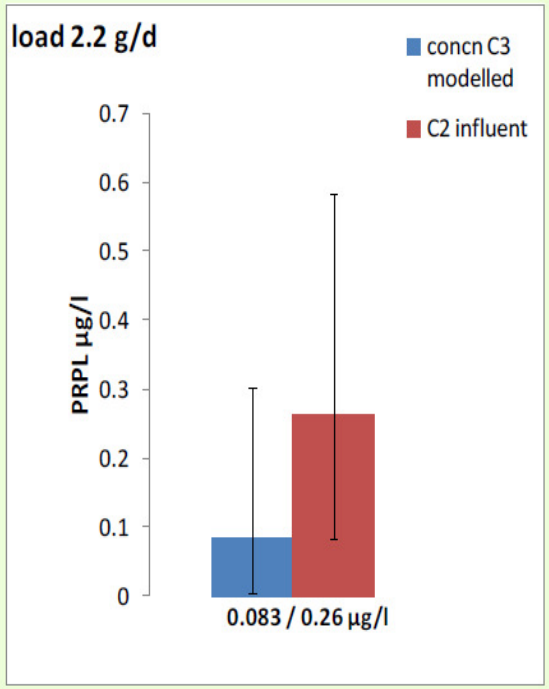


Graphs produced by Atkins

Stirling

Propanolol

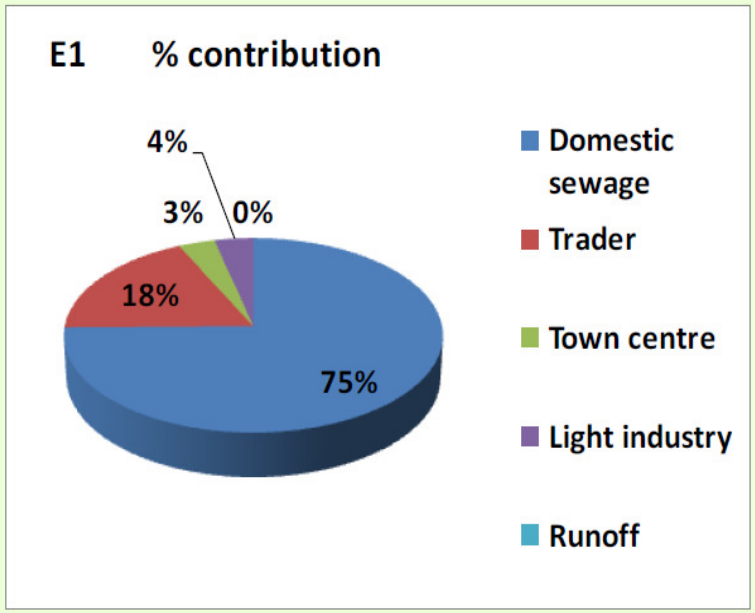


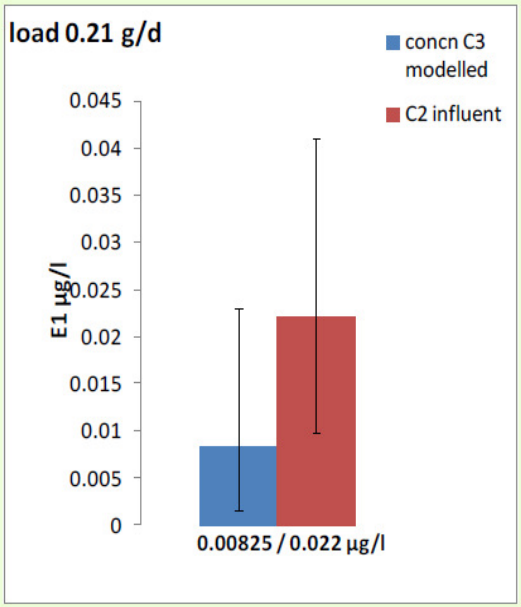


Graphs produced by Atkins

E1 - Oestrone

Stirling

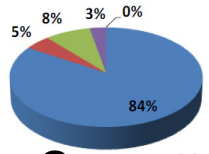




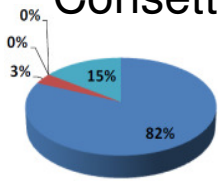
75% of the E1 load in Stirling catchment coming from domestic sources.

Graphs produced by Atkins

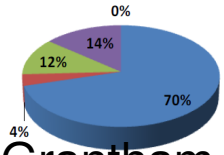
Blackburn



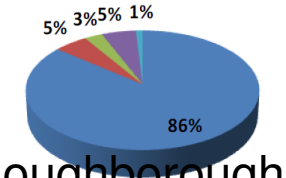
Consett



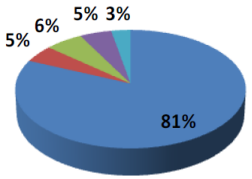
Fazakerley



Grantham

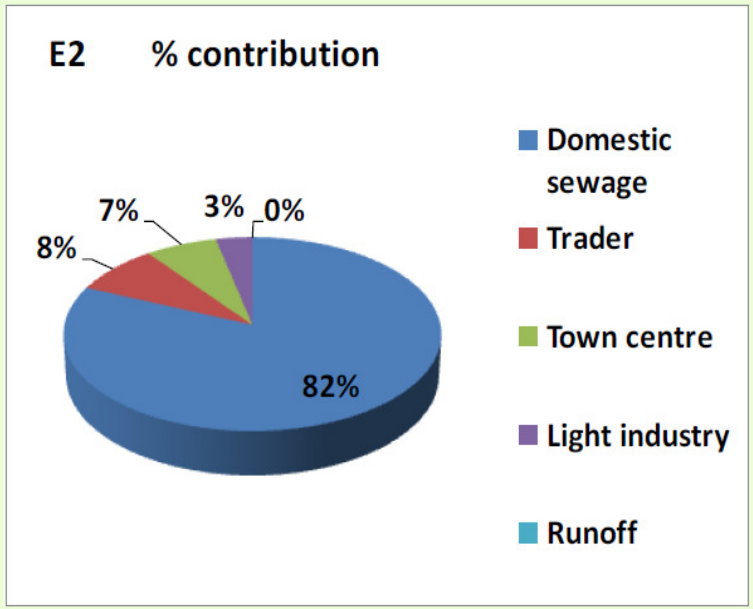


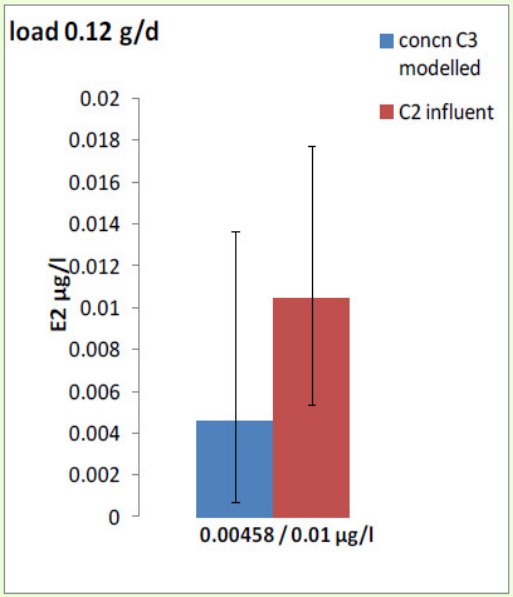
Loughborough



E2 -17β oestradiol

Stirling

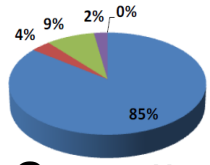




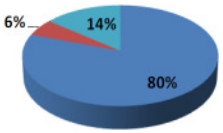
82% of the E2 load in Stirling catchment coming from domestic sources.

Graphs produced by Atkins

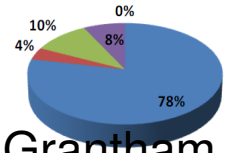
Blackburn



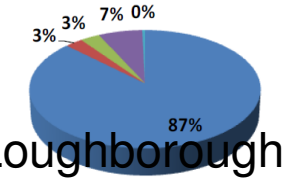
Consett



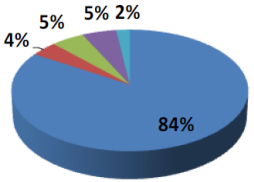
Fazakerley



Grantham

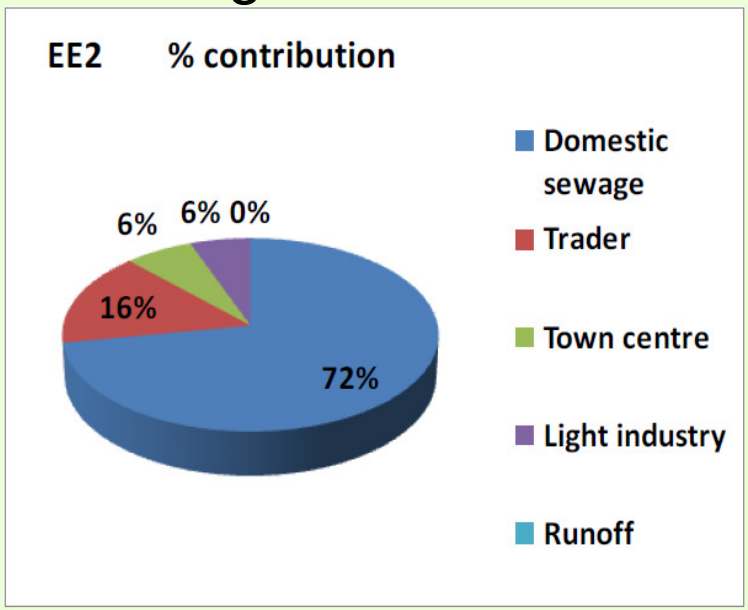


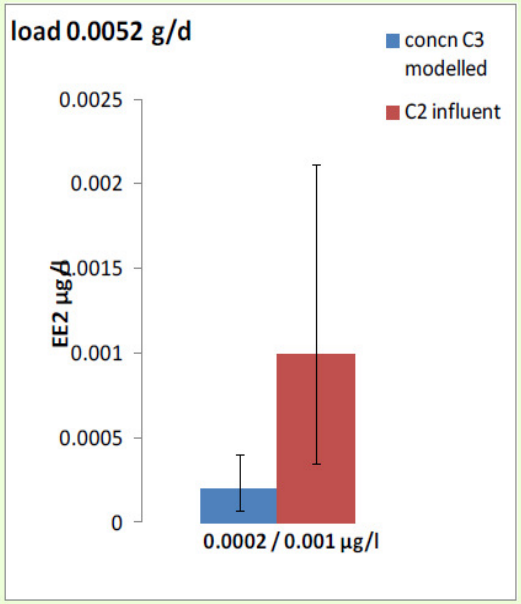
Loughborough



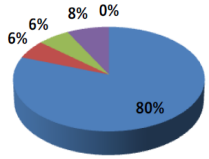
EE2 - 17α ethinyloestradiol

Stirling

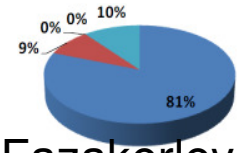




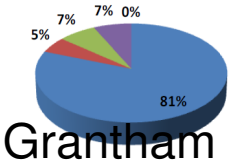
Blackburn



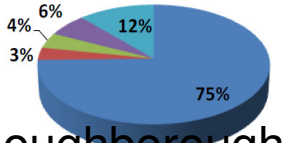
Consett



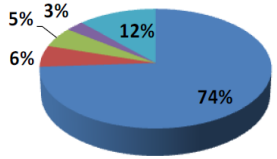
Fazakerley



Grantham



Loughborough



72% of the EE2 load in Stirling catchment coming from domestic sources.

Graphs produced by Atkins

Summary

- **Strategic approach**
- Identify the scale of the problem
- Where it comes from
- Mechanisms available
- Prioritisation

- **Chemical Investigations Programme**
- Sewage treatment works good at removing the sanitary determinands
- Sewage treatment works may not be best placed for pharmaceutical removal
- Pharmaceutical source apportionment within the sewer network is not soley limited to domestic sewage.

SEPA
Scottish Environment Protection Agency

Thank you

Any questions?