The Prevention of Sewage Pollution from Cabin Cruisers in the River Shannon Basin

By

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Declaration of Authenticity

I declare that the work presented in this document for assessment on the programme of study leading to the award of M.Sc. in Environmental Protection is entirely my own work and that all sources have been acknowledged.

Signed: C. McCormack

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Date: June 08

Abstract

This study evaluates the current procedures adopted regarding the prevention of pollution from Cabin Cruisers on the River Shannon, specifically on the navigable inland (freshwater) waterway, from Ballyconnell, Co. Cavan to Killaloe, Co. Clare.

Preventative methods include the sensitive adoption of legislation and codes of practice, the creation of environmental awareness and the use of appropriate technology.

The research methods include a review of relevant literature, consultation with stakeholders, collection of empirical data and statistical analysis to reveal non-biased points of consensus.

The evaluation of legislation reveals it to be layered, but quite complete. The correlation of redundant and emergent legislation could be the most effective tool for future prevention of pollution from Cabin Cruisers in the Shannon River Basin. The involvement of the EPA regarding the creation of a Code of Practice, scrutiny of inspectory practice and policy concerning infrastructure all require urgent action.

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1. Introduction and Scope

The Shannon is Ireland's largest waterway, visually characterised by unspoilt and varied countryside. Punctuated by lakes, overhung by trees; it is an internationally renowned haven. Historically, the Shannon was navigated by Saints, Scholars, Vikings and Normans alike. Heritage sites along the Inland Waterway narrate our lineage and survival.

The river and its floodplains are widely defined as areas of conservation for wildlife. Thus, management of this fine resource requires a knowledgeable application of technical and legal standards.

Water Quality is intrinsically related to water use. The River Shannon Water Quality Objectives characterize the river as a source of abstraction for drinking water; it is also a receptor for agricultural, industrial and municipal wastewater.

The waterway has a high recreational amenity value; as bathing water, a fishing resource, for navigation and other watersports. As a navigable waterway, the Shannon is one of the finest examples in Europe. Initially engineered under British Rule, the original management of the seasonal variation of water levels and channel depths is still valid, though technological advances have been adopted. Hydrological control, drainage works and abstraction for power generation are monitored and maintained.

The amenity value of the waterway is under continual development. Control of the consequences is tedious. Use of the river is controlled by legislation, generated by both National and Community mechanisms.

Stakeholders are so numerous that hierarchical significance is difficult to assess (Table 1.1). A challenge is posed by the use of powers of enforcement exercised by equal partners. The navigation is jointly managed by three bodies: Waterways Ireland, the Electricity Supply Board and the National Inland Fisheries Authority. Legislation provided some of the interested parties, for example, the Environmental Protection Agency (EPA) with specific tasks defined. Eighteen Local Authorities influence operational compliance along the Shannon, though a total of twenty six planning authorities must be factored in to any evaluation. National Bodies such as Fáilte Ireland and the Heritage Council promote the use of the inland waterways within this legal framework. Voluntary groups such as Inland Waterway Association of Ireland (IWAI) and the Irish Boat Rental Association (IBRA) each lobby in relation to their mission.

Since the year 2000, the Water Framework Directive (WFD) imposes new water catchment area management requirements. The EU wide mandate requires monitoring and communication, administered via River Basin Management Plans, administered by River Basin Districts (RBDs). Within the realm of the Water Framework Directive the Environmental Protection Agency is the National Competent Body. It was adopted into law in Ireland in 2003.

This study explores the possible impacts of sewage dumping from a substantial Cabin Cruiser flotilla, the applicable legislation and the current compliance to same within the Shannon River Basin (Fig. 1). It is hoped to discover points of consensus among stakeholders.

Table 1.1 Stakeholders Relevant to the Investigation

Stakeholder	Relevant Brief	Statutory Requirement
Environmental Protection Agency	National Environmental Inspectory & Advisory Body.	EPA Act, 1992 and consequential Regulations
Local Authorities: County Councils: Limerick, Clare, North Tipperary, Offaly, Westmeath, Longford, Roscommon, Kerry, Galway, Leitrim, Cavan, Sligo, South Tipperary, Mayo, Cork, Laois, Meath. City Council: Limerick	Provision of Drinking Water Treatment of Sewage Prevention of Water Pollution. Monitoring of Water Quality Standards. Regional Management Plans. Planning Permission	Public Health (Ireland) Act, 1878, and consequential Regulations Water Pollution Act, 1977 -90, and consequential Regulations Planning and Development Acts, 1963 & 2000, and consequential Regulations
Waterways Ireland, all island authority (ex Office of Public Works) Shannon Navigation	Development of Inland Waterways Inspectory Body of Waterways Ireland geographically confined to Shannon.	Formed 2000, following North-South Agreement, 1998 The Shannon Navigation Act, 1990, and consequential Regulations

National Inland Fisheries Authority, Shannon Regional Fisheries Board	Water Pollution Control, Preservation of fish stocks	Fisheries (Consolidation) Act, 1959 Fisheries Act, 1980, and consequential Regulations
Electricity Supply Board	Monitoring and Maintenance of hydrological change	Shannon Electricity Act, 1925 and consequential Regulations
Fáilte Ireland	Development of Irish tourism	N/A
The Heritage Council	Protection of Heritage Sites, cultural and built	N/A
An Taisce. The Irish National Trust	Independent Body dedicated to Education and Guardianship of the Natural Environment	Given precedence to act on behalf of the common good in the Planning and Development Act of 1963
IBRA, The Irish Boat Rental Association	Representative Body of Commercial Rental Cruisers	N/A
IWAI, Inland Waterway Association of Ireland	Organisation of Private Boat Owners (non-exclusive).	N/A

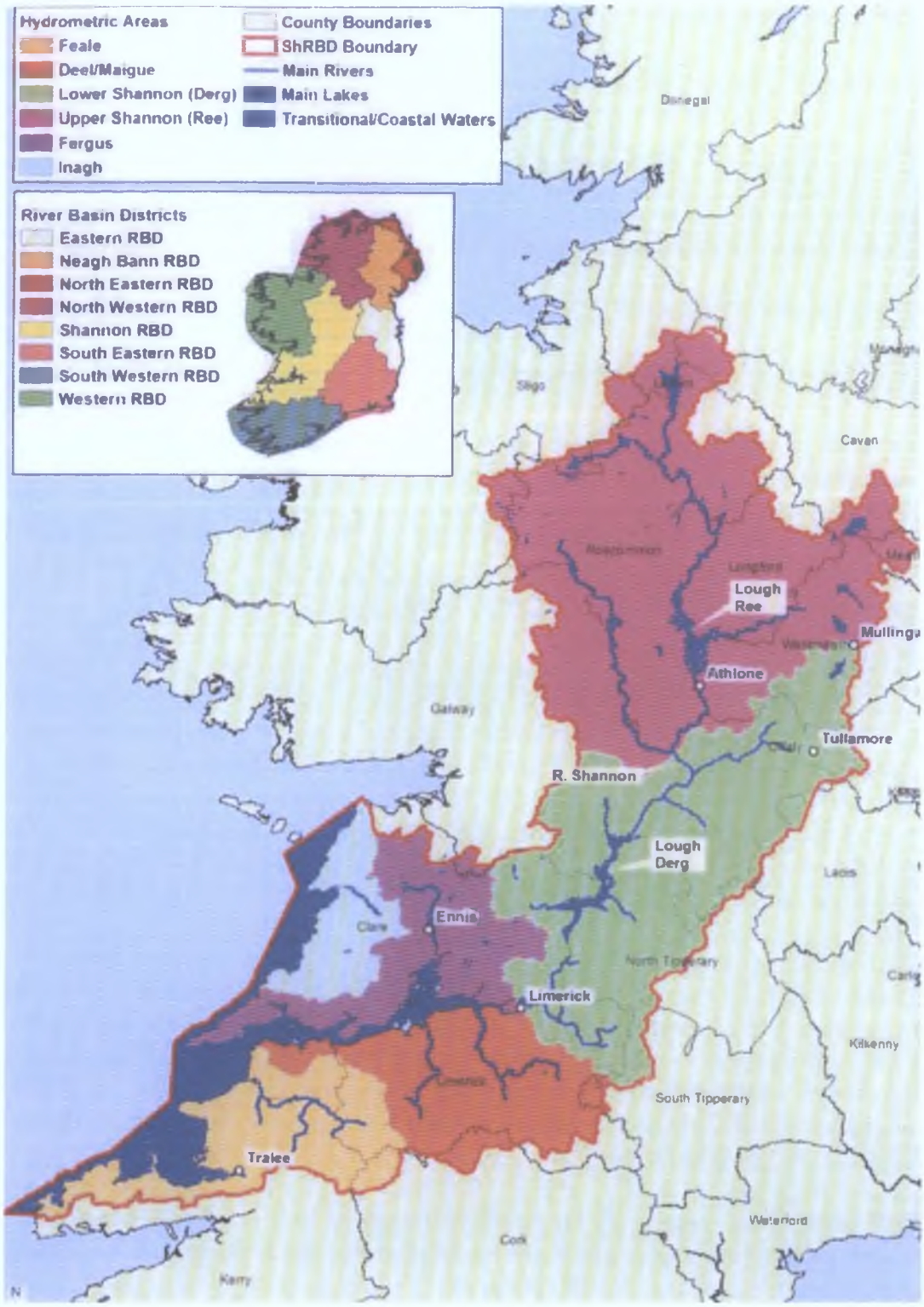

Figure 1 Map of Shannon International River Basin District

(Source: SRBD Characterisation Report, 2005)

2 Literature Review

The literature review comprises of an overview of both primary and secondary documentation related to current protocol and best practice. Primary literature for consideration includes generic and prescriptive legislation, both National and Community law. Secondary literature is generated as a result of primary literature, and includes Authority Reports, Codes of Practice, Academic Papers and statistical evidence. The selected literature is notionally free of bias. All documents, including legislation, are referred to by the most common name or reference currently used among practitioners.

2.1 Legislation

In Ireland, the development of legislation to prevent water pollution was relatively slow. Throughout the first half of the twentieth century, political freedom and its immediate economical consequence preoccupied the minds of legislators. Until the late 1970s, much of the water legislation in place was inherited from Westminster, and a century old (The River Pollution Act of 1876, and The Public Health Act of 1878, etc). Attempts were made after the Second World War to avert dumping of "deleterious matter" to water. In comparison to other European states, Ireland's population density was low, and concentrated around the coastlands. Industrial development coincided with population density. Much of our slothful economy was based on agricultural activity, which, until the introduction of the "farm subsidy approach", was largely subsistent and non-intensive. Following acceptance into the "Common Market" in the early 1970s, the economy was forced to achieve certain goals. With process

intensification the requirement for increased pollution, and subsequent control became obvious. Concurrently, An Fóras Forbartha began surveying surface water quality, particularly where nutrient enrichment had lead to a reduction in water quality. A new era in water management was evolving.

Table 2.1 Typical Legislative Controls on Scheduled Sectoral Activity

SECTOR	*CONTROLS*	**APPLICABLE LEGISLATION** *Non-exhaustive list*
Industry	Emission Limit Values Water Quality Standards Permits/ Licensing Monitoring Penalties	Water Pollution Act, 1977-90, Planning & Development Acts, 1963 & 2000 Environmental Protection Act, 1992 and Protection of the Environment Act, 2003 Water Framework Directive
Agriculture	Emission Limit Values Water Quality Standards Permits/ Licensing Monitoring Penalties	Water Pollution Act, 1977-90 Planning & Development Acts, 1963 & 2000 Nitrates Directive Phosphates Directive Water Framework Directive
Municipal Water and Waste Water	Emission Limit Values Water Quality Standards Permits/ Licensing Monitoring Penalties	Water Pollution Act, 1977-90 Planning & Development Acts, 1963 & 2000 Drinking Water Directive, Urban Waste Water Directive Water Framework Directive

Throughout EU and National legislation, the emphasis lies principally on the polluting effects of industry, agriculture and municipal activity. The effects of recreational

navigation are rarely suspect, and invariably do not appear directly in community legislation. Except for the direct requirements of the various Shannon bye-laws, a type of "compliance by default" exists, whereby the activity must assure the "prevention of pollution" at all costs, with generic standards being tentatively adopted.

The search for applicable standards, therefore, requires an indirect approach. The use of generic limit values must be applied to the activity, carefully assessing the significance of supporting clauses, sub-paragraphs and contingency measures required.

2.1.1 The Conservation of Water Quality

The Fisheries (Consolidation) Act of 1959 implemented some pollution control, particularly under chapter II outlining the *Protection of Fishing Waters from Poisoning and Pollution.* Section 171 (1) (b) states that any person who "permits or causes to fall into any waters any deleterious matter, shall, unless such act is done under and in accordance with a licence granted by the Minister under this section, be guilty of an offence". Licensing or Certification of effluent discharge was introduced by this section. This legislation permitted the prosecution of a Local Authority for breach of section 171. Section 172 of the same Act prevents the entry of "deleterious liquid" to water. The section requires that any *receptacle containing or conveying deleterious matter within thirty yards of water* be maintained in such a way as to prevent the passage of that matter to water.

This was legislation based on generic principles, not specific limit values. Many of the requirements were not compulsory, thus enforcement and prosecution proved difficult. Since the Supreme Court Ruling (Shannon Regional Fisheries Board vs Maguire, 1994)

the application of the Act has been reinvigorated. The "*permits or causes to fall to water*" clause of section 171 of the Fisheries (Consolidation) Act of 1959 has since been the grounds of many cases.

Section 172 established enforceable pollution control over third parties. This section has been widely enforced regarding agriculture and industry. The application of Section 172 to the discharge from boats has never been used, nor regarding storage of sewage in Private Marinas.

The Water Pollution Act of 1977, as amended in 1990, was the most comprehensive piece of generic water legislation ever adopted in Ireland.

No. 1 of 1977 was concerned with the prevention and control of pollution to all waters. Section 3 of the Act prohibits the entry of "polluting matters" as defined in section 1 to waters. The definition is of broad interpretation:

> *"... includes any poisonous or noxious matter, and any substance (including any explosive, liquid or gas) the entry or discharge of which into any waters is liable to ..... or to render such waters harmful or detrimental to public health or to domestic, commercial, industrial, agricultural or recreational uses."*

Section 4 introduced new discharge licensing requirements regarding trade and sewage effluent, with provisions laid out in Sections 5-9. Section 4 licences are required for any discharge to a watercourse, and may be applicable to some marinas; however they are not commonly sought.

Sections 10-14, 28 and 30-32 are concerned with the power to administer in the case of pollution. In particular, Section 12 gives the Local Authority power to "require measures to be taken to prevent water pollution".

The Management of Water Quality via regional Plans is required under section 15, confirmed by the demands of, in particular, sections 22 – 32. These Water Quality Management Plans cross Local Authority boundaries, requiring co-operation from all other Authorities "sharing" a water body. Regional Water Quality Management Plans are now superseded by the River Basin Management Plans required under the Water Framework Directive, 2000, adopted in Ireland, as prescribed, in 2003.

Certain discharges, under the 1978 Water Pollution Regulations do not require a licence, including

"*domestic sewage, not exceeding in volume 5 cubic metres in any period of 24 hours, which is discharged to an aquifer from a septic tank or other disposal unit by means of a percolation area, soakage pit or other method*", (typical unifamiliar domestic septic tanks) and also,

"*effluent discharged from a Sanitary Authority in the course of the performance of its powers and duties, other than from a sewer*".

Section 27 of the Water Pollution Act permits the minister to enact any legislation regarding vessels, defined as water craft. This section has never been availed of. Authorities can be prosecuted under s171 of the Fisheries (Consolidation) Act, 1959. Section 34 of the WPA, repealing sections 171 and 172 of the 1959 Fisheries Act, was punctually not made effective, allowing remedy for non-compliance of local authorities. Consequently, the Local Government (Water Pollution) Act, 1977 (Commencement Order), 1996 enforced the statutory value of sections 171 and 172 of the Fisheries Act.

Where the collection and storage of sewage is required, some form of waste management plan is required. The sewage must either be transferred to the Waste Water Treatment Plant or spread to land. Section 51 of the Waste Management Act of 1996 requires the correct application of slurry to land. (The Kingdom of Spain took this issue to the EU Parliament in 2005, claiming that slurry was not waste but a bye-product. The case was won by Spain)

Section 28(1) (g) of The Planning and Development Act of 2000 requires collaboration of planning authorities, where encroachment of territories is a factor. This collaboration would be relevant in the case of planning permission where the proposed activity would encroach on the waterways. Waterways Ireland and the Regional Fisheries Board have statutory Consultee Status regarding the impact of the construction of berthage, marinas, etc., along the navigational channel.

New Drinking Water Regulations (S.I. 278 of 2007) applicable in Ireland since March 2007 give the EPA the power to effect prosecutions on Local Authorities. Local Authorities must notify discharge non- compliances to the EPA and inform the public, initiating the need for corrective action as prescribed by the EPA. Should the indication be ignored, the EPA can prosecute.

2.1.2 The Control of the Navigational Channel and Vessels

Following the Shannon Navigation Act of 1990, (No 20 of 1990) further prescriptive regulation to control navigational activity was adopted. Legislation controlling the use of the Shannon was primarily included in "The Shannon Act" of 1839 (The Act of British Parliament 2&3 Vict., 61) as amended or extended. This legislation defined the

boundaries of the "navigable channels" under section 39 as; ... *the river, lakes, the related canals, locks, harbours, wharfs, landing places, piers, quays, weirs and other works*... The powers of Commissioners were defined under the Shannon Act as "... *to undertake the care, conservation, management, control, maintenance, restoration, repair, improvement, extension and development of the Shannon Navigation...*"

The 1841 Survey of the Shannon limited the territory associated with this legislation to *"... the edge of the waters of the Shannon when they are at their Ordinary Summer Level, that is to say seven feet on the upper sill of Hamilton's Lock..."*

The definition of the navigation channel and the Powers of Commissioners in the Shannon Act are directly transferred to the Shannon Navigation Act of 1990, sections 1 and 2 respectively. Under section 2 (e), the commissioners reserve the right to build or alter structures surrounding the navigation:

> *" ... construct, alter, underpin, repair or improve any lock, quay, harbour, dry dock, weir, fish pass, slipway, navigation aid, pumping station, hydroelectric station and ancillary works, building, towpath, bridge, aqueduct, embankment, culvert, pipe or drain or road (other than a public road within the meaning of the Local Government (Roads and Motorways Act) of 1974) on, over, beside or under the navigation channel"*

Section 3 gives the Commissioners powers to make bye-laws in order to make the channel manageable. Such bye-laws may include orders to close the channel, repair, prohibit activity, regulate bathing, prohibit the building of culverts, bridges, or other structures which may limit the use of the channel, and also the abstraction of water... the regulation of fishing in the channel (not interfering with the regulations or bye-laws

made under the Fisheries Acts 1959-80), the passage of boats and the recovery of fees, tolls and charges for mooring, etc.

Penalties are fixed at £1,000.00 for a Summary Conviction and £100.00 for every day of continuing contravention, and/or 6 months imprisonment. A fine of £5,000.00 is applicable for an indictable offence, with £500.00 applicable for every day of continuing contravention, with a prison sentence of up to 2 years optional. Corporate consent or connivance will be attributable to the directors, managers, secretaries, etc.

The Shannon Navigation (Construction of Vessels) Bye Laws, 1992 (S.I. No. 79 of 1992) were written to clarify the requirements of "waterworthy" boats and vessels. Cabin Cruisers fit into the category described as "vessel", a craft of any description which is not a "boat". A boat is "an open or undecked punt, canoe, skiff, scull, row boat or other such boat designed to be propelled by oars or sail and not propelled by an engine of more than 15 horsepower". In contrast, a cruiser is covered, decked and propelled by a motor exceeding 15 horsepower.

The regulations define the liabilities of owners for contravention of bye-laws written under section 3 of the Shannon Navigation Act. Contraventions include the use of a vessel of unsafe hull construction, lack of anchor and chain, mooring lines (bow and stern) and fenders. The regulations require flotation devices, life belts, boarding ladders and a distress flag and/ or pyrotechnic signals. The minimum requirement regarding inboard engines, fuel tanks, exhausts, battery and electrical circuits are outlined in regulation 9. Fire extinguishers in relation to vessel length and cooking facilities are obligatory under regulation 11. The remaining regulations specify the design

requirements for LPG, cooking appliances and water heaters, with specific reference to ventilation.

The Shannon Navigation (Construction of Vessels) Bye Laws, 1992 , S.I. No. 79 of 1992 was formulated to assure that craft were safe. It failed to include a requirement for the construction and fitting of toilets, and sewage created by users. This factor was remedied by the drawing up of The Shannon Navigation (Construction of Vessels) (Amendment) bye-laws of 1994, (S.I. No. 421 of 1994).

This amendment, to be inserted after regulation 13, states clearly

> *Regulation 14. A toilet fitted to a vessel shall be so constructed and fitted as to prevent polluting matter from being discharged or passing into the navigation.*

The bye-law became applicable on the 1st April of 1996 for all vessels, and from 1st June 1995 for vessels registered after that date. It supposes that such non-polluting toilets will need to store sewage on board, and that receptacles will be provided for the emptying of such sewage storage systems on the banks of the waterway. This issue has been contentious since the publication of the bye-law. A search for a corresponding statutory requirement to construct pump-out stations has proven futile.

S.I. No. 80 of 1992, known as The Shannon Navigation Bye-Laws of 1992, was written in exercise of the powers conferred under section 3 of The Shannon Act of 1990. This regulation gives power to the Authorised Officers to board and inspect any vessel or boat, acquire relevant information and give direction to the master of the craft. The regulation prohibits the navigation of unregistered vessels (registered via The

Commissioner, 51 St Stephen's Green, Dublin 2). The Authorised Officers may remove a vessel from the navigation if there is a contravention.

Other requirements of this bye-law include navigational measures to ensure safety, such as the maximum draft of the vessel, port to port passage, starboard overtaking, lights and torches, speed restrictions, passage through locks and bridges and mooring duties. Considerations toward fellow waterway users, such as downstream precedence and sail boat priority are designated. Crew member factors including maximum and minimum numbers, abuse of alcohol and/ or drugs, and issues regarding expected behaviour on the waterway are outlined.

The bye-law also indicates the cooperation required when maintenance is necessary, and how users are not to create obstruction of the navigation or of the access to the river or surrounding lands, including the entry of persons, vehicles or animals without the consent of the Commissioner.

Regulation 28 stipulates the prohibitions applicable in order to protect the navigational environment. Such prohibitions include, under R28 (1) (c)

A person shall not –

Deposit or leave litter or offensive matter in the navigation, other than in receptacles provided for that purpose

This subsection may infer receptacles required for the collection of sewage, though it does not specifically state such.

The remaining text outlines the conditions of removal or sale of a vessel by the Commissioner, mooring charges, maximum docking periods, charges, penalties and appeals.

Recent Legislation, The Waste Water Discharge (Authorisation) Regulations, 2007 (S.I. No. 278 of 2007) requires the licensing or certification of effluent discharges from Local Authorities, based on population equivalents. This new legislation is of relevance where a pump-out station adds considerably to the established population equivalent of a Waste Water Treatment plant. At present, pump-out stations are pumped into the sewerage system directly, no storage or metering is carried out. The cost of the pump-out services to the user is fixed at £5.00 per service via the Shannon Navigation (Amendment) Bye Laws, 1994 (S.I. No. 66 0f 1994). In this case, the European wide "Polluter Pays Principle" is applied precariously to the consumer.

2.1.3 The Management of EU Water Resources

Since the establishment of the EEC, legislation to protect the Community's water resources has been constant. Some of this legislation is of particular value to this study. The Surface Water Directive 75/ 440/ EEC requires that water for abstraction be classified. The guideline values outlined in the annexes are based on the World Health Organisation indications of 1978, and the established UK system. They were further developed creating Categories A1, A2 and A3 as nominal qualities regarding treatment required, with A1 being most satisfactory for drinking water abstraction. Criteria include freedom from pathogens, non-toxicity, quality of supply and consistent quantity. A total of 46 parameters must be assessed. (Table 2.2)

This standard was due to be repealed by the WFD, Article 7 and Annex V in 2007. The WFD creates the 5 categories "high status, good status, moderate status, poor status and bad status". The target for 2015 is to achieve at least good status in all EU water bodies.

Table 2.2 Water Quality Category as outlined in the Surface Water Directive

Category ex surface source (75/ 440/ EEC)	**Treatment required in order to achieve drinking water status as required by 98/83/ EC.**
A1	Physical treatment and disinfection (rapid filtration & chlorination)
A2	Normal physical & chemical treatment, standard disinfection
A3	Intensive physical & chemical treatment, & rigorous disinfection

The Urban Waste Water Directive, 91/271/ EEC created the parameters for discharges from Waste Water Treatment Plants (WWTP). Treatments must scrub the wastewater to the prescribed standard. (Table 2.3)

Table 2.3 Discharge Parameters as prescribed by the Urban Waste Water Directive

Parameter	Concentration (Art 2)	% Reduction (Art 2)
BOD5 at 20°C	25 mg/l O2	70-90 or 40 per Art 2
COD	125mg/l O2	75
Total Suspended Solids	35mg/l @ >1,000 p.e. 60mg/l@ 2,000-10,000p.e.	90@ > 1,000 p.e. 70@ 2000-10,000 p.e.

The Water Framework Directive, 2000/60/EC (WFD) is the most extensive piece of water- related legislation to be produced by the EU. It will progressively repeal many other EU directives on water quality. It lays down policy on sustainable water supply and use. It directs exploitation towards assuring drinking water for the European population into the future by demanding the maintenance of water quality status. The entire aquatic environment is to be protected by the reduction of priority hazardous substances and the introduction of measures to assure correct usage.

The introductory paragraph to the WFD boldly declares:

"Water is not a commercial product like any other but, rather, a heritage which must be protected, defended, and treated as such"

This courageous statement draws attention to the more permanent qualities of water, the eternally recyclable substance that sustains all life. It reiterates the inheritable value of water.

Prior to the establishment of the WFD, extensive research was carried out at a Community level.

- In 1988, the Community Water Policy Ministerial Seminar concluded that there was a need for the EU to "improve the ecological quality of Community surface waters" (O.J. C.209, 9.8.1988, p.3).
- In 1992, a blueprint for sustainability was established at the United Nations Conference on Environment and Development, known as AGENDA 21.

- The European Environmental Agency exposed "Water in the Community is under increasing pressure from the continuous growth in demand for *sufficient quantities of good quality water...*" (EEA, 1995)

The Water Framework Directive (WFD) imposes efficient management of water resources at a local, regional, national and community level. The requirement to communicate findings to the Commission periodically creates the responsible implementation of a self-declaring quality assured system.

While many of the purposes of the WFD are philosophical in nature, it transfers these philosophies to prescriptive legislation and also introduces some new quality standards. The requirements are organised in "articles", each of which must be complied to. An overview of these articles gives some indication, directly or indirectly, of how the navigation of leisure craft must become compliant to Community demands.

Article 1 outlines the fundamental purposes of the Directive. They include:

- The prevention of deterioration of present water status
- The promotion of sustainable water use
- The protection of the aquatic environment (surface, groundwater, coastal, etc.), reducing the introduction of priority hazardous substances.
- The reduction of pollution
- The mitigation of the effects of floods and drought

The tone of Article 1 is idealistic, and imposes a moral obligation to comply "for the common good", the basis of all law.

As is common, Article 2 comprises of definitions applicable to this piece of legislation. Definitions are specific:

"Surface water status" is that determined by the poorer of either ecological or chemical status,

"Pollutant" is that referred to in Annex VIII,

"Water use" is that identified under Article 5 and Annex II, having a significant impact on the status of water.

The identification of individual River Basin Districts (RBDs) and co-ordination of administrative arrangements within the River District Basins is outlined in Article 3. Of particular interest is the requirement under Article 3 to identify a national "Competent Body". This function has been assigned to the Environmental Protection Agency in Ireland.

Environmental Objectives are highlighted in Article 4. The "prevention of deterioration of the status" is the underlying value. All waters must achieve "good status" by 2015, with no deterioration in those bodies achieving "high status" at the publication of the Characterisation Reports. Article 4, 3 allows for Member States to designate a body of surface water as artificial or heavily modified. Part (a) (ii) mentions navigation, including port facilities, or recreation, (iv) includes water regulation, flood protection, land drainage. While some of the canal zones or ports may be consistent with these descriptions, it is highly unlikely that the Shannon be designated as "heavily modified" as one of its primary uses is the abstraction of water for drinking purposes.

Part 5 (b) of Article 4 requires that Member States ensure

- for surface water, the highest ecological and chemical status possible is achieved, given impacts that could not reasonably have been avoided due to the nature of the human activity or pollution.

Part 6 of the same article allows for temporary deterioration, due to *force majeure*, where circumstances could not have been reasonably foreseen, but part (a) continues with the conditions "all practicable steps are taken to prevent deterioration in status..."

Within the framework, new sustainable human development, which may cause deterioration may not constitute a breach, under Article 4, part 7, where all practicable steps to mitigate the adverse impact have been taken, the reasons for such modifications (of over-riding public interest, and /or the benefits to the environment and to society outweigh the interests in question) are outlined in the RBMP, as required by Article 13, or are not technically feasible, or disproportionately costly.

Part 9 of Article 4 requires that the demands of the WFD guarantee at least the standards adopted by existing Community legislation.

Article 5 of the WFD requires the "Characterisation" of the RBDs established under Article 3. Annexes II and III are applicable, permitting the profiling of all types of water bodies; rivers, lakes, coastal waters, etc. This characterisation report is to be completed at 13 years and reviewed every 6 years thereafter.

Article 6 provides for a Register of Protected Areas, as defined under Community legislation. This register should be compiled 4 years after the entry of the Directive and include areas of particular ecological value, wildlife habitats, etc.

Waters used for the abstraction of Drinking Waters are the subject of Article 7. Annex V gives monitoring parameters for waters providing 100m3 per day average. All waters used for the abstraction of Drinking Waters must comply with the Drinking Water Directive (80/778/EC) and more recently 98/83/EC. "Safeguard Zones" may be

established in order to protect such waters. Article 7 with Annex V will be totally applicable by 2012, revoking the Surface Water Directive.

Article 8 refers to the monitoring of Water Quality. All technical specifications and standardised methods must be set down as per requirement of Article 21 concerning the activities of Regulatory Committees.

The "Polluter Pays Principle" allows for the recovery of costs of water services, under Article 9. Annex III regarding economical analysis of the RBDs is applicable.

By 2010, water pricing policies should be in place for all EU water bodies. Cost distribution throughout industry, domestic users and agriculture are mentioned. Leisure usage is not specified.

Article 10 is of particular interest regarding the subject under debate, establishing the need for a combined approach for point and diffuse sources. Part 2 requires (a) that emission controls are based on *best available techniques or* (b) the relevant *emission limit values* or, (c) *best environmental practices.* Where particular standards for leisure cruisers are not adopted, this approach is to be implemented.

The "Programme of Measures" (Table 2.4) made mandatory under Article 11 implements Annex VI, part A. In particular, part 3 defines "basic measures" as the minimum requirements to be complied with. Sub-section (h) of part 3 refers to "diffuse sources liable to cause pollution and requires that measures to prevent or control the inputs of pollutants must be made". These may take the form of *prior regulation*, such as a prohibition on the entry of pollutants into water, prior authorisation or registration based on *"general binding rules"* where such a requirement is not otherwise provided

for under Community legislation. This section has direct implications regarding the prevention of pollution from cabin cruisers.

Table 2.4 Directives to be considered when applying a programme of measures

Annex VI: LIST OF MEASURES TO BE INCLUDED WITHIN THE PROGRAMMES OF MEASURES: Part A:

Measures required under the following Directives:

(i) The Bathing Water Directive (76/160/EEC);

(ii) The Birds Directive (79/409/EEC);

(iii) The Drinking Water Directive (80/778/EEC) as amended by Directive (98/83/EC);

(iv) The Major Accidents (Seveso) Directive (96/82/EC);

(v) The Environmental Impact Assessment Directive (85/337/EEC) as amended by Directive 97/11/EC;

(vi) The Sewage Sludge Directive (86/278/EEC);

(vii) The Urban Waste-water Treatment Directive (91/271/EEC);

(viii) The Plant Protection Products Directive (91/414/EEC);

(ix)The Nitrates Directive (91/676/EEC);

(x) The Habitats Directive (92/43/EEC);

(xi) The Integrated Pollution Prevention Control Directive (96/61/EC).

Article 11, with Annex VI parts A and B give a very complete support for compliance. Both preventative and corrective actions are suggested by the indications given.

Part 4 of Article 11 establishes "supplementary measures" as those measures designed and implemented in addition to the basic measures defined in part 3. Annex VI, Part B contains a non-exhaustive list of typical supplementary measures. While some of the measures may not be relevant to the prevention of pollution from leisure craft, others are very workable.

Table 2.5 Further measures to be included within a programme of measures, relevant to subject matter

Annex VI: LIST OF MEASURES TO BE INCLUDED WITHIN THE PROGRAMMES OF MEASURES: Part B:

(i) legislative instruments

(ii) administrative instruments

(iii) economical or fiscal instruments

(iv) emission controls

(v) codes of good practice

Also

(xv) educational projects

And

(xvii) other measures

Part 5 continues to outline the measures required to prevent pollution, stating that where Environmental Objectives under Article 4 are not being met, "additional measures" must be taken. These additional measures may include:

Investigation of the Causes

Examination of Permits

Review of Monitoring Procedures

Improvement of the environmental standards laid down in Annex V.

Administrative provisions are outlined in Article 13, requiring the establishment of River Basin Management Plans. Annex VII provides the reference material.

Public Information and Consultation is fundamental to the ethos of the Framework, and must be assured throughout the management process. Article 14 makes this a matter of compliance for each RBD.

Article 15 requires the periodic reporting of data to the Commission. Having established a RBMP, the RBD must cross check characterisation as per Article 5 against monitoring of water quality as per Article 8. Risk assessment as a strategy against water pollution is prescribed under Article 16, referring specifically to the target based risk assessment methodologies of Council Regulation 793/93 and the Directives 91/414/EEC (the Plant Protection Products Directive, 1991) and 98/83/EC (The Drinking Water Directive, 1998). Such target based risk assessment should focus on aquatic ecotoxicity and human toxicity via the aquatic environment.

In response to Article 15, the Commission is bound, under Article 18, to create a "Commission Report" at 12 years and every 6 years thereafter.

Article 16 requires the re-writing of a Dangerous Substances list in Annex X which will revoke the Dangerous Substances Directive (DSD) of 1976. Annex I of the DSD contains a list of "black" priority substances and "grey" priority substances. Among the "grey" substances are those which may *have an adverse affect on the oxygen balance, particularly ammonia and nitrates.*

Punitive measures are to be determined by each Member State as required by Article 23. These penalties shall be "effective, proportionate and dissuasive".

The WFD is a legislative tool based on cyclical compliance (Table 2.6), and should result in efficient preventative and corrective actions if compliance to the individual articles is met.

Table 2.6 Elements of management system applicable to WFD:

Step	**Objective**
1.	Establishment of Core Policy
2.	Identification of Required Standards
3.	Hazard Analysis & Risk Assessment
4.	Gap Analysis
5.	Preventative and/or Corrective Action
6.	Periodic Review
7.	Realignment with Core Policy

2.1.4 The Assessment of Environmental Indicators

The Strategic Environmental Assessment Directive (2001/42/EC) was transposed into national legislation via European Communities (Environmental Assessment of certain Plans and Programmes) Regulations of 2004 (S.I No 435 of 2004) and the Planning and Development (Strategic Environmental Assessment) Regulations of 2004 (S.I No 436 of 2004). The River Basin Managements Plans required under the WFD fall under the remit of S.I. No. 435 of 2004. The SEA Directive requires that certain plans would be cross referenced with a number of environmental indicators prior to their adoption or review, in order to allow for preventative or corrective action. The Directive recommends the selective adoption of the following indicators, subsequent to evaluation: Air, Water, Climate Change, Soil, Materials, Transport, Biodiversity, Human Health, Built and Cultural Heritage.

2.2 Authority Reports. Codes of Practice, Best International Practice

2.2.1 Environment

The Shannon rises from limestone bedrock in the Cuilcagh Mountains on the Cavan/ Leitrim border and swells from upland stream to estuary over 260 km. It creates a border for counties Cavan, Leitrim, Longford, Roscommon, Westmeath, Galway, Offaly, Clare, Tipperary, Limerick and Kerry. Other counties through which the numerous Shannon tributaries flow are Sligo, Mayo, Cork, Laois, Meath and Fermanagh.

The ecological value of the 18,000km² river basin is internationally recognised. The 60 habitat types and 25 protected species recognised under the Habitats Directive are largely marine and surface water categories. One third of Ireland's Special Areas of Conservation are water sites. Enhanced by temperate seasonal diversity, the Shannon is home to many native and migratory species, creating an extensive Food Web.

The river basin is a broad, flat, kidney shaped depression, speculated to have been formed following recent tectonic subsidence (Mitchell, 1990). Seasonal winter flooding is the norm, with some 3,500 ha of callows are formed along the length of this generous waterway (Nairn *et al.*, 1988). Since the Arterial Drainage Act of 1945, many of these callows are disappearing, and with this occurrence, the associated ecosystems.

The disappearance of these microcosms was examined and partially quantified in the early 1980s (Bruton and Convery, 1982). There has been a notable reverse in this trend, with many ecosystems (120 confirmed with 17 advertised) now being protected as Areas of Special Preservation under Habitats and Wildlife Preservation Legislation.

More than 1,600 small, shallow lakes characterise the basin, with three substantial lakes punctuating the river, namely Lough Allen (30km2), Lough Ree (100km2) and Lough Derg (120km2). 70% of the land forming the basin is agricultural, with non-point pollution of certain notoriety.

As one of eleven key indicators of water quality, fish kills (Table 2.7) are linked to anthropogenic activity. Data prepared by the Central Fisheries Board links the 34 fish kills reported throughout Ireland in 2006 to their causative factor. Notably, almost half of the causes are categorised under "other" or "unknown".

Table 2.7 Causative Factors of Fish Kills

Agriculture	Industry	Sewage	Eutrophication	Other	Unknown
5	2	7	5	10	5

(EPA, 2006*a*)

The number of fish kills has reduced by approximately half over the past twenty years. Water quality within the Shannon River Basin District is improving (Table 2.8)

Table 2.8 Condition of Channel

% length channel	**3 year cycle ending 2006**	**3 year cycle ending 2003**
Unpolluted	67%	63%
Slightly polluted	22%	21%
Moderately Polluted	11%	15%
Seriously Polluted	0.7%	0.6%

(EPA, 2006*a*)

An alternative study produced by the EPA highlighted that 28% of the total river length was unsatisfactory to some degree, and that 15% of lakes on the River Shannon were classified as being less than satisfactory. (EPA, 2006*b*)

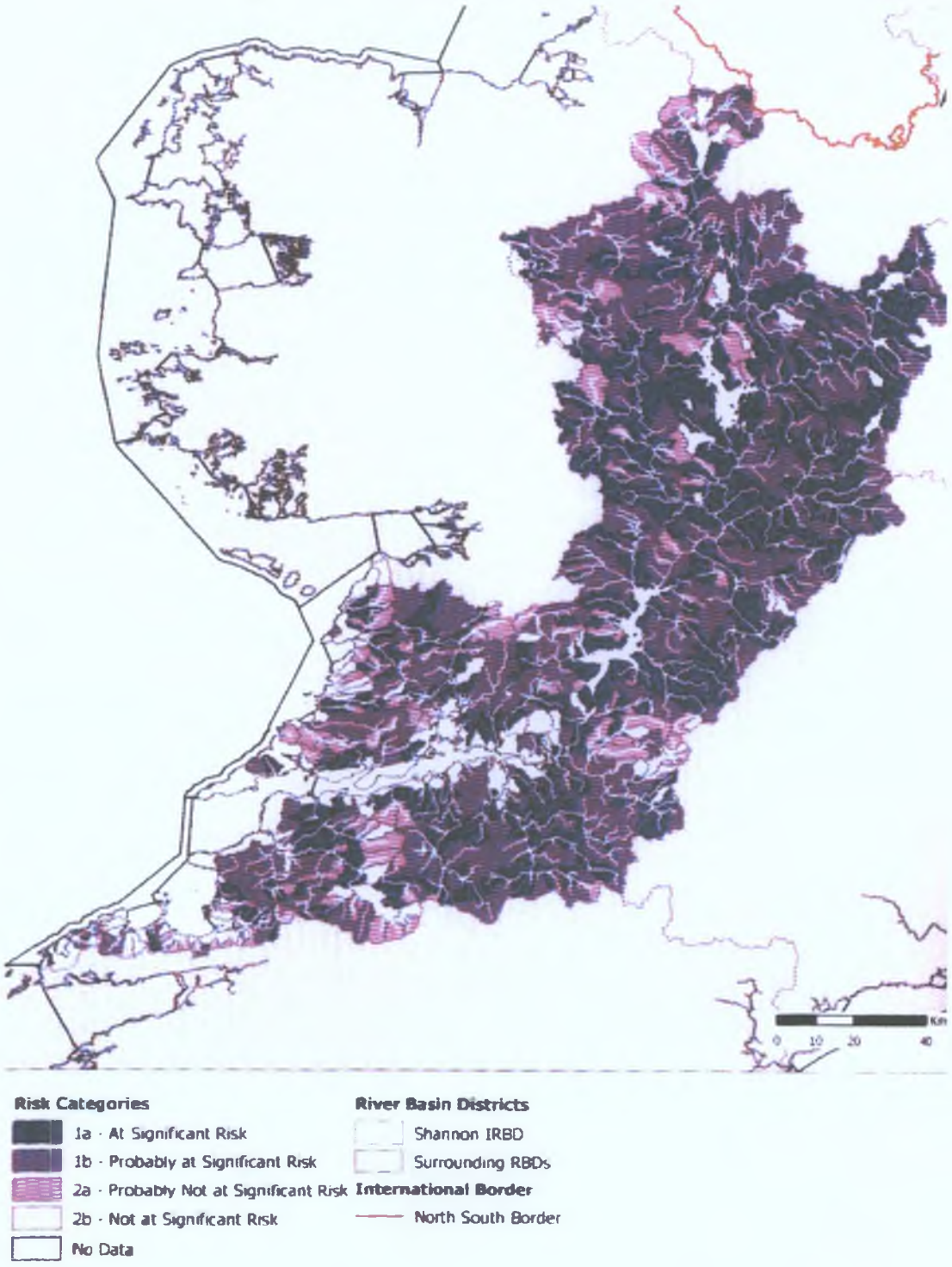

Figure 2 Summary of River Bodies following Risk Assessment

(Source: SRBD Characterisation Report, 2005)

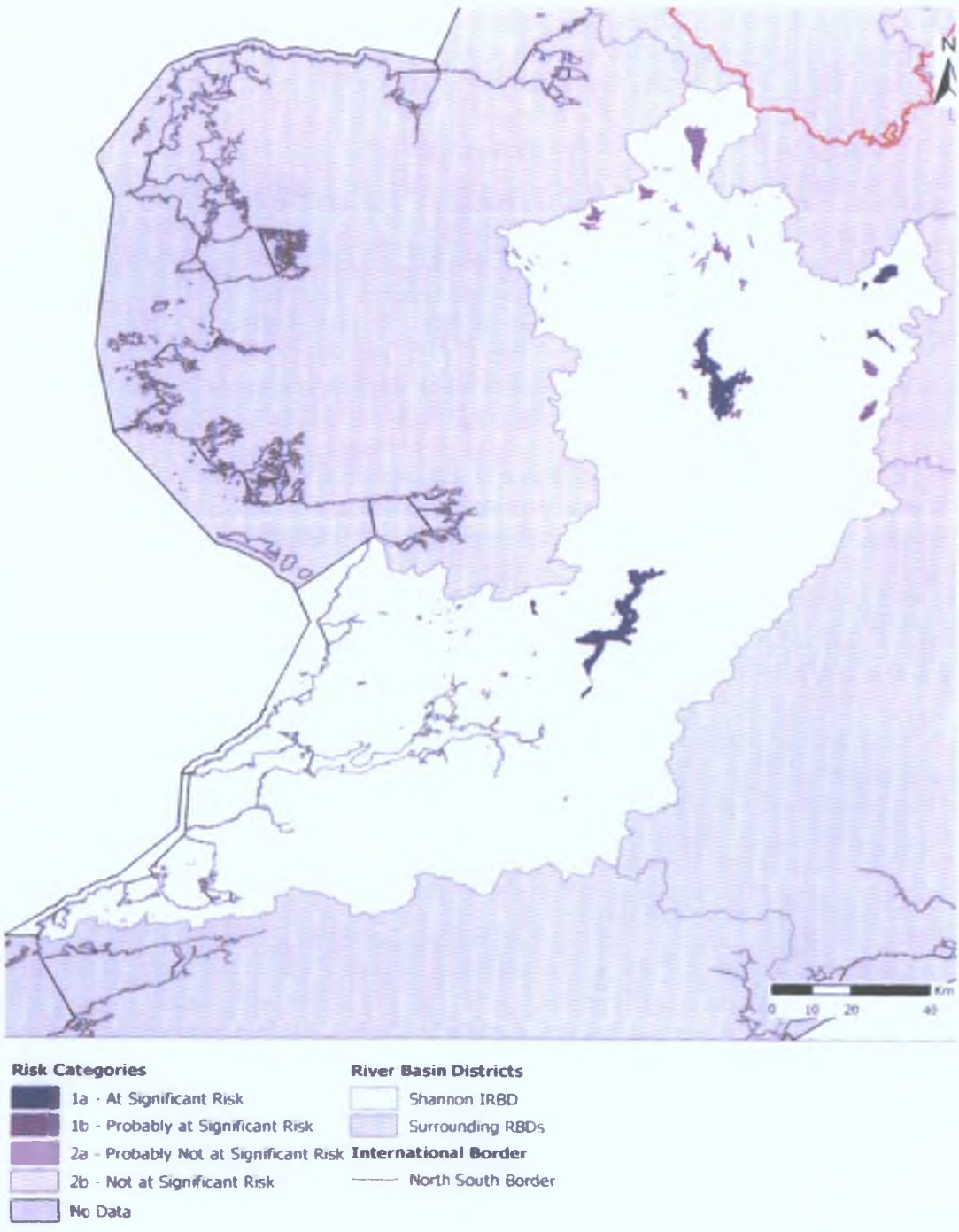

Figure 3 Summary of Lake Bodies following Risk Assessment

(Source: SRBD Characterisation Report, 2005)

2.2.2 Protection of Waters for Abstraction

The Shannon River Basin sustains some 670,000 people. Extensive population coincides with towns like Carrick-on Shannon (16,000), Athlone (17,500) and Ennis, which is home to some 24,300 persons (CSO, 2006). Limerick City and environs has a population of 90,800, with the population density peaking at more than 160 persons per square kilometre. Concurrent with urbanisation, industry has developed along the banks of the Shannon.

Land use around the Shannon is mostly agricultural (70%). While pollution is emitted to water from industrial, agricultural and municipal waste water treatment plants, direct flushing of sewage to the aquatic environment from cabin cruisers is estimated to be one percent of Shannon pollution (Bowman, 2000)

Recent drinking water contamination outbreaks have highlighted the need for better control of surface water sources:

- Of the 16 EU member states where cryptosporidium is a notifiable disease, Ireland has the highest rate of incidence, with 13.7 cases per 100,000 persons. (Semenza & Nichols, 2007)
- *E. coli* as an indicator of human or animal waste in water supply was detected in almost 1% of public water supply samples (77 out of 944 water supply zones, which serve 81.8% of the Irish population), with an 8% intermittent contamination factor in public water supplies. (EPA, 2007)
- *Enterococci* were found in 3.7% of public water supply samples in 2006. (EPA, 2007)

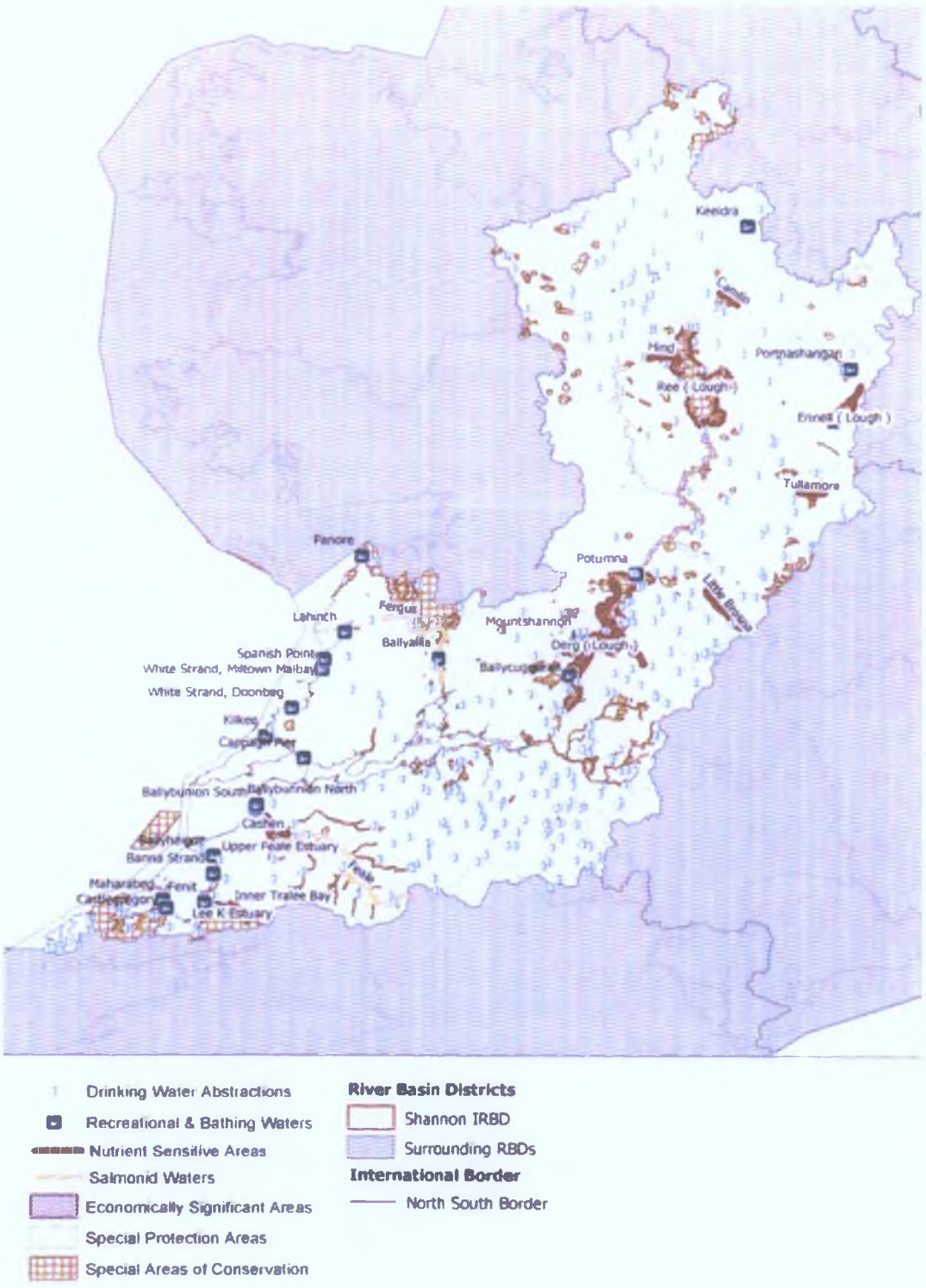

Figure 4 Drinking Water Abstraction Points in the SRBD

(Source: SRBD Characterisation and Analysis Report, 2005)

The protection of surface waters in Ireland is imperative. Data relating to drinking water sources demonstrates how dependant the Irish population is on exposed water.

Table 2.9 Abstraction of Drinking Water Source Types

%	Source Type
83%	Surface Waters
11%	Groundwaters
6%	Natural Springs

(EPA, 2007)

Many of our natural reservoirs from which drinking water is abstracted coincide with commercial marinas, particularly on the major lakes. Public harbours tend to be built at larger municipal districts, and often coincide with the outlets from waste water treatment plants. Sourcing polluting incidents is difficult. Proactive intervention by Local Authorities requires compliance to both water quality legislation and planning legislation.

The World Health Organisation (WHO, 2004) recommends a proactive approach to the prevention of contamination incidents, based on constant risk assessment:

- Assessment of risk to quality of supply from catchment to consumer
- Monitoring of those risks
- Management of supply during normal and incident conditions

The EPA reiterates this approach in its recent findings:

point sampling can no longer be relied upon as the sole indicator of a safe and secure drinking water supply... all risks associated with the supply must be identified, monitored and managed to ensure that drinking water standards are met... the ability of water suppliers to provide clean and wholesome drinking water will now be determined by a wider range of assessment, controls and management than had previously been the case." (EPA, 2007)

This corroborates the earlier preoccupation that Ireland could potentially fall short of the WFD target in the time left for remediation unless an all out effort is made by all stakeholders and policy makers to retrieve the situation.

2.2.3 Navigation

The Irish Canal Age began in 1731 with the building of the Newry Canal (the first summit canal in the British Isles) and ended in 1859 (Delany, 1992). Unlike the English canals which were built to cope with industrial growth, Irish waterways were developed in an effort to progress industry and commerce in Ireland. The Shannon is linked to other river systems by both lateral canals (cuts) and summit level canals. Canals are, in ecological terms intermediate between rivers and lakes, between flowing and standing waters (Murphy and Eaton, 1981). They are isolated from natural drainage because of the puddle-clay that lines them. Unlike natural waterways, canals require boat traffic to prevent the invasion of vegetation (Murphy and Eaton, 1983).

A characteristic worth noting is the extensive network created by canals, linking the cities of Dublin, Limerick, Belfast and Waterford. At its most northerly navigable

point, the Shannon is joined by the Ballinamore-Ballyconnell Canal (now named the Shannon-Erne Waterway, re-opened since 1994) to the Erne Waterway. The Suck Navigation route extends westwards from Banagher. The Grand Canal links the Shannon to Dublin to the East. The last leg of the restoration of the Royal Canal at Clondra, Co. Longford will re-establish the central triangle of navigable waterways. Other waterways such as the Barrow Navigation and the Ulster Canal (in the process of renovation as part of the North-South agreement) complete the waterway system in the island of Ireland.

The Shannon is navigable from Ballyconnell in Co. Cavan to Killaloe in Co. Clare. At Killaloe the locks lower the level of water to that of the mouth of the Shannon (some 30 metres), where freshwater and seawater mix.

Following independence from Britain, Coras Iompair Eireann became the National Transport Authority and the guardian of the Waterways. For many years, up until the late 1960s, trade boats (barges) transported goods from Dublin via canals and the Shannon to less accessible areas. This guardianship was transferred to the Office of Public Works, Inland Waterways Division, in 1986.

Waterways Ireland, previously known as Inland Waterways, was one of six new all-island bodies established following the North/ South Agreement of April 1998. Inland Waterways was dedicated to the maintenance, development and restoration of the Navigational Channel and improving the amenity value of the inland waterways within the Republic of Ireland. All legal rights and duties of Waterways Ireland were inherited from its predecessor. Shannon Navigation is the Statutory Authority with jurisdiction within the River Shannon Basin.

There is a total length of more than 1000 km of navigable waters in the island of Ireland, 250km of which is controlled by Shannon Navigation. The impact of management of this resource is of primary importance. Present day usage of the waterways is wholly leisure related, and maintenance or renovation projects are directed solely at the development of tourist and leisure sector. Quantifying the impact on water quality created by cruisers on the freshwater Shannon is difficult, and can at best only be estimated. An overview of registration data provided by Shannon Navigation/Waterways Ireland gives data regarding recent trends in cruiser usage (Table 2.10). Registration as required by The Shannon Navigation Bye Laws of 1992, S.I. No. 80 of 1992 is conditioned particularly by engine type and size. The data includes cruisers by definition, but also speed boats with more than 15 horsepower engines and the few working vessels owned, for example by Waterways Ireland and the ESB.

Current registration data does not take into account:

- vessels removed from the Shannon Navigation
- vessels in circulation from the Shannon-Erne Waterway
- differentiations between vessel function
- private and rental craft proportions

Registration numbers have steadily increased year on year over the past seven years, with 2006 registrations more than doubling those of 2001. The cumulative registration data demonstrates an eight-fold increment in vessel numbers over a fifteen year period. At the publication of this report, vessel number 8100 had been observed in use.

Table 2.10 Shannon Navigation cruiser registration data, 2000-2007

Year	No. of vessels registered
2000	380
2001	304
2002	299
2003	367
2004	359
2005	523
2006	622
2007	638

(Source: Waterways Ireland, 2008)

Table 2.11 Cumulative Registration Data: 1992 – 2007

Year and incidence of relevant significance	**1992 Shannon Navigation Bye-Law** (S.I. No. 80 of 1992) **requires registration of vessels**	**2000 Waterways Ireland created following North-South Agreement in 1998**	**2007 Most recent data available**
Approx. No. of vessels registered	1000	3500	7000

(Source: Waterways Ireland, 2008)

Shannon Navigation Lock Passage Numbers for the years 2005-2007 demonstrate the trends regarding river traffic:

Table 2.12 Lock Passage Numbers, 2005 - 2007

Year	**Total No. Lock Passages**	Total No. Private Boats	**% Private Boats**	Total No. Hire Boats	**% Hire Boats**
2005	**68521**	24501	**36%**	44020	**64%**
2006	**67366**	24634	**37%**	42732	**63%**
2007	**66942**	24554	**37%**	42388	**63%**

(Source: Waterways Ireland, 2008)

A steady 1:2 ratio of private: hire boats presently in circulation is evident. Comparative data for the year 1998 reveals that of 74,642 lock passages, 78% were hire boats, a 1:4 ratio. In 1998 hire boats made up 17% of registered boats on the Shannon Navigation system. In the same year, Hire Boat Companies sold some 10,000 boat weeks (Kirk McClure Morton, 2001). With an average of 6 persons per boat, 423,000 person days arose from the use of hire boats. Simultaneously, some 105,000 person days arose from private boat use, which when added summed a total of 528,000 person days on the River Shannon. At present, rental boat numbers are estimated at 400 units (<6% of registered boats). Their usage is, however, much more intense than that of privately owned boats: voyage length and continuity of use are two important factors.

2.2.4 Tourism

A considerable share of Ireland's tourism is centred on the River Shannon. An Bord Fáilte, with the various Cruiser Hire Companies, is promoting the use of the River Shannon for commercial recreational purposes. It is estimated the almost €70 million per annum is generated by the water amenities offered on the Shannon and related on-shore facilities (CSO, 2006). Fáilte Ireland recently published evidence to suggest that family income in the West of Ireland is three times more dependant on Tourism than Dublin, but that enterprise in Dublin collects five times more revenue form tourism than its Western counterpart.

This activity creates considerable seasonal environmental impacts. Environmental impacts of tourism are generally related to the provision of drinking water, transport of consumer goods, waste management and sewage disposal.

Along the Shannon, many significant focal points of tourism exist. Many villages and townlands coincide with public harbours and jetties (generally short term storage of vessels) and private marinas (generally long term storage of vessels). At these points the management of a cruiser population may be environmentally unsustainable. While notably boosting the local economy, cruiser population may out-number local population, particularly during the peak season.

It is precisely the "green wealth" of the Shannon that attracts visitors. A study carried out by the Department of the Environment for Northern Ireland confirmed similar characteristic environment with regard to the Shannon-Erne Waterways; the lack of urban-industrial development that has otherwise constrained levels of economic welfare has ensured the retention of rare habitats for both flora and fauna in the hedgerows,

lough marshes and isolated islands. (DoENI, 1991). As cruiser activity increases pressures are exerted on this treasured natural resource.

Many tourists seek the tranquillity associated with being close to a body of water. At a fundamental psychological level the water environment seems to exert a strong positive influence upon well-being (Hartig *et al.*, 1991). Nowhere is this more notable than when applied to inland cruising or boating holidays, where the appreciation of the quality of the natural conditions is pivotal to the enjoyment of the experience. The essential appeal of river corridors lies at least in part, in their tranquillity and richness of flora and fauna (Green and Tunstall, 1992).

There is little doubt regarding the fact that river users are, in general, river lovers. However, some false perceptions of environmental conditions exist; brown water colour is misinterpreted as heavily polluted, whereas the characteristic ruddy shade is purely an indicator of its bogland inheritance. Also, it is commonly believed that the addition of organic matter to the river provides enriched fish food. Thus, the dumping of "natural waste" to water would seem justified. There is little consideration given to the respiratory requirements of aquatic organisms.

A code of practice is required to minimise harm to the aquatic environment and the consequential depletion of fish stocks that provide an important ancillary recreational activity (Guyer and Pollard, 1997).

In the context of the development of the Shannon River Basin, tourism poses some serious infrastructural problems, particularly related to land use and transport issues. Much of the river is bordered by rural Heritage sites. The location of these sites leaves them very vulnerable to environmental neglect. Sustainable development of tourism

would require that all concentrations should be encouraged close to urbanisation already served by municipal drinking water, waste management systems and sewerage. Planners must address these matters in order to achieve sustainable environments for the twenty first century (Hall, 1999).

Human impacts on host communities vary from those felt by residents who are not involved in tourism but find that their lives are seasonally influenced by sectoral activity, to those employees who are displaced to the host community in order to earn. The level of environmental knowledge acquired by these two groups will directly affect tourist behaviour while visiting and consequential environmental impact.

Discussions on the sustainability of tourism are well documented (eg: Bramwell *et al.*, 1996, Cater and Lowman, 1994). The "Self Destruction Theory of Tourism" considers that tourism contains the seed of its own destruction; tourism can kill tourism, destroying the very environmental attraction which visitors come to experience (Glasson *et al.*, 1995).

Holder (1988) maintains that the development of a uniquely attractive natural environment attracts an elite tourist; as expansion continues, the elite move out, opening the way for mass tourism; prices inevitably drop in relation to expendable income, and the sustainability of the project becomes questionable. Tourism, in many ways, sows the seed of its own demise. The environment is often prey to both the success and ruin of tourism.

Tourists tend to have a transient knowledge of their destination, and an insignificant awareness of the related environment. In an era of increased leisure time and disposable income, environmental restrictions on tourism are difficult to enact (Brown, 1998). Most

tourists choose their destination based on aesthetic values or leisure pursuit, few have a specific association with the natural environment. With regard to water tourism, studies indicate that "the majority of those cruising the waterways are *unfocused users*" (Jacob and Shreyer, 1980)

Private boat owners add to tourism by their use of river bank facilities. Direct investment in vessels and mooring rentals has increased by approximately 400% over the past decade. The supply and demand of moorings has lead to an exponential growth in the number of facilities available. If current land uses continue unchanged, it will be very difficult to meet the demands of the Water Framework Directive (Donoghue *et al.*, 2006) Research has shown that the private owner sector is more focused on environmental issues.

Interest groups such as the Inland Waterway Association of Ireland try to unify member efforts, creating awareness through quarterly publications. Recent membership numbers stand at 2,500, less than a third of the number of private boats registered. Private owners have reported frustration at the lack of pump-out facilities along the banks. Many of the facilities installed are malfunctioning. Anecdotal evidence suggests that many boat owners who have retrofitted their boats have since abandoned the use of holding tanks due to erratic provision of on-shore services (www.iwai.ie).

2.3 Sewage Pollution from Cabin Cruisers

Sewage Pollution from cabin cruisers is both diffuse to open river and a point source, where sewage accumulates in marinas, locks or harbours. Cabin Cruisers are defined as such because they provide domestic facilities that are adequate for short term

habitation. They are differentiated from day-boats in the provision of eating, sleeping and hygiene facilities. Generally, a cruiser will have one toilet/ hygiene cubicle, but two cubicles are common particularly in boats equipped for 4 or more persons.

2.3.1: On-Board Toilet Systems

The management of sewage from cabin cruisers is a consequence of the toilet installation. Early barges (1870s onwards) had no toilet installation, sewage was thrown over-board, or on-land facilities were availed of. Coinciding with the growth in the rental market and the enhancement of domestic hygiene facilities, on-board toilets became more commonplace (Table 2.13)

The use of the marine (sea) toilet became common in the 1960s. Retrofitting was required for many of the vintage cruisers. This installation adapted the plumbing mechanisms used on board ocean liners to the requirements of fitting the system to the double skin of wooden, steel or fibreglass hulls of many of the newer vessels. Raw sewage was thrust directly into the aquatic medium via a series of pipes connected by vacuum pumps and seals. A search for an EN standard applicable to the installation of a sea toilet has proven unsuccessful.

In the 1970s with the sophistication of preservative agents, the chemical toilet was further developed. This system was similar in concept to the traditional dry toilet, but the sewage was preserved by chemical stabilizers. The double-chamber assemblage was self-contained and did not require piercing the double skin of the vessel. This bi-cistern toilet uses chemically treated water from an upper cistern which flushes to a second lower reservoir containing a complimentary product. The resulting slurry is chemical

rich, and due to a lack of special receptacles, is disposed of to the normal sewerage system. It was considered to be less refined than the sea toilet as it required periodical emptying.

Recently, there have been attempts to re-create a dry toilet system adequate for use on board a vessel. Notably the prototype developed by The Ecology Technology Centre "De Twaalf Ambachten" in Holland is nearing completion (www.de12ambachten.nl). Issues have been raised regarding the hygiene risks during the storage, as the system uses biodegradable bags with a paper seal.

2.3.2 Holding Tanks

In the 1990s, with EU legislation requiring pollution controls and the sensitisation of the cruising population to environmental issues, holding tanks were retrofitted to a number of sea toilet installations. The process involved redirecting the plumbing to an integrated tank. The system should create a hermetical containment, which requires to be emptied periodically to the municipal sewerage system via a pump-out station.

Safety issues associated with the use of holding tanks have been found to be widespread. Aesthetical issues such as odours from the storage of sewage on board herald the more sombre issue of sewage gases. The installation of the holding tanks foresees the need to ventilate gases, but many users have noted disturbing overnight smells. Sewage gases are nervine depressants and anaesthetics, and can form explosive mixtures. Other common complaints include the leakage of liquors to the bilge, caused by vibrations on the joints. This issue creates serious hygiene problems and an increase of corrosive fibreglass exposure known as osmosis.

Table 2.13 Issues Related to Toilet Installation

	Sea Toilet	Sea Toilet & Holding Tank (Y valve shut)	Chemical Toilet	Dry Toilet (prototype)
Cost of installation	Expensive (~€1,000.00)	Very expensive (~€1,800.00)	Economical (~€100.00)	Unknown
Disposal Fee (continual)	N/A	Pump-out Fee	N/A	Depending on pathway
Technical difficulties related to installation	Requirement to pierce double skin of hull	Piercing of skin if river water required to flush system	N/A	N/A
Disposal Pathway	To aquatic environment	To pump-out station and WWTP	To WWTP if no receptacle provided	To WWTP Or compost Or MWTP
Compliance to S.I. 421/1994	No	Yes	Yes	Yes
Environmental issues	Negative effect on Water Quality	Increased population equivalent to WWTP	Increased p.e. to WWTP, chemical rich slurry	Faecal contamination of receptors (water/ soil)
Health & Safety issues (cruiser)	N/A	Gases, odours, hygiene	Chemicals, hygiene	Odours, possible gases, hygiene

Further issues relating to the maintenance of holding tanks include the need to wash the tank out thoroughly to prevent the creation of gases and acidic liquor. This practice also increases water usage, and additional disposal issues.

The Scottish Environmental Protection Agency guideline regarding holding tanks is very basic but highlights the requirement for systems "to be sealed or rendered inoperable" (SEPA, 2001). The USEPA guideline is more specific "the valve should always be kept closed and locked within the 3-mile limit from shore" (USEPA, 2003). A search for an EN standard applicable to the installation of a holding tank has proven unsuccessful.

2.3.3 Pump-out Stations

On-shore pump-out stations are required in order to permit the collection and disposal of sewage stored in on-board holding tanks. The legislation regarding the installation of non-polluting toilets on-board vessels was published in 1994; however, no statutory requirement regarding the provision of pump-out stations exists. There has been no EPA Code of Practice or guideline drawn up to enhance practitioner understanding of the requirements. The Department of the Environment, Heritage and Local Government provides grant aid for local authorities wishing to install a pump-out station, to date no specification has been drawn up, although the Sykes vacuum pump installation in use would seem to be common along the waterways. Smart-card type is diverse, with users complaining of malfunction. The Scottish EPA in Pollution Prevention Guideline No14 is quite specific regarding pump-out stations, requiring that they be connected to the public foul sewer (SEPA, 2001). Reference is made to the prevention of overflows and to the correct collection of chemical toilet waste (i.e.: not to package sewage treatment

tanks or septic tanks). Guidance on the requirements for correct sewage disposal where no foul sewer exists is outlined in PPG No 4 (SEPA, 2000). The USEPA is similarly specific in its guidelines regarding marina design and installation, requiring adherence to technical guidance documents (USEPA, 2000).

At present, there are 14 pump-out stations along the Shannon Navigation. (Figure 5). The Inland Waterways Association of Ireland proposes the need for at least 33 on the basis of two thousand vessels needing half an hour each to empty tanks over daylight hours on any weekend (www.iwai.ie).

The stations are owned and managed, in the main, by the local authorities. Difficulties arise regarding the allocation of maintenance staff for the stations, smart card variation along the Shannon, and availability of mooring space. Five of the Pump-out Stations on the Shannon Navigation are owned and managed by Waterways Ireland, and are, in general terms, successfully managed. Negotiations to change the ownership of local authority pump-out facilities to Waterways Ireland are under way, hindered by the lack of standardisation presently observed.

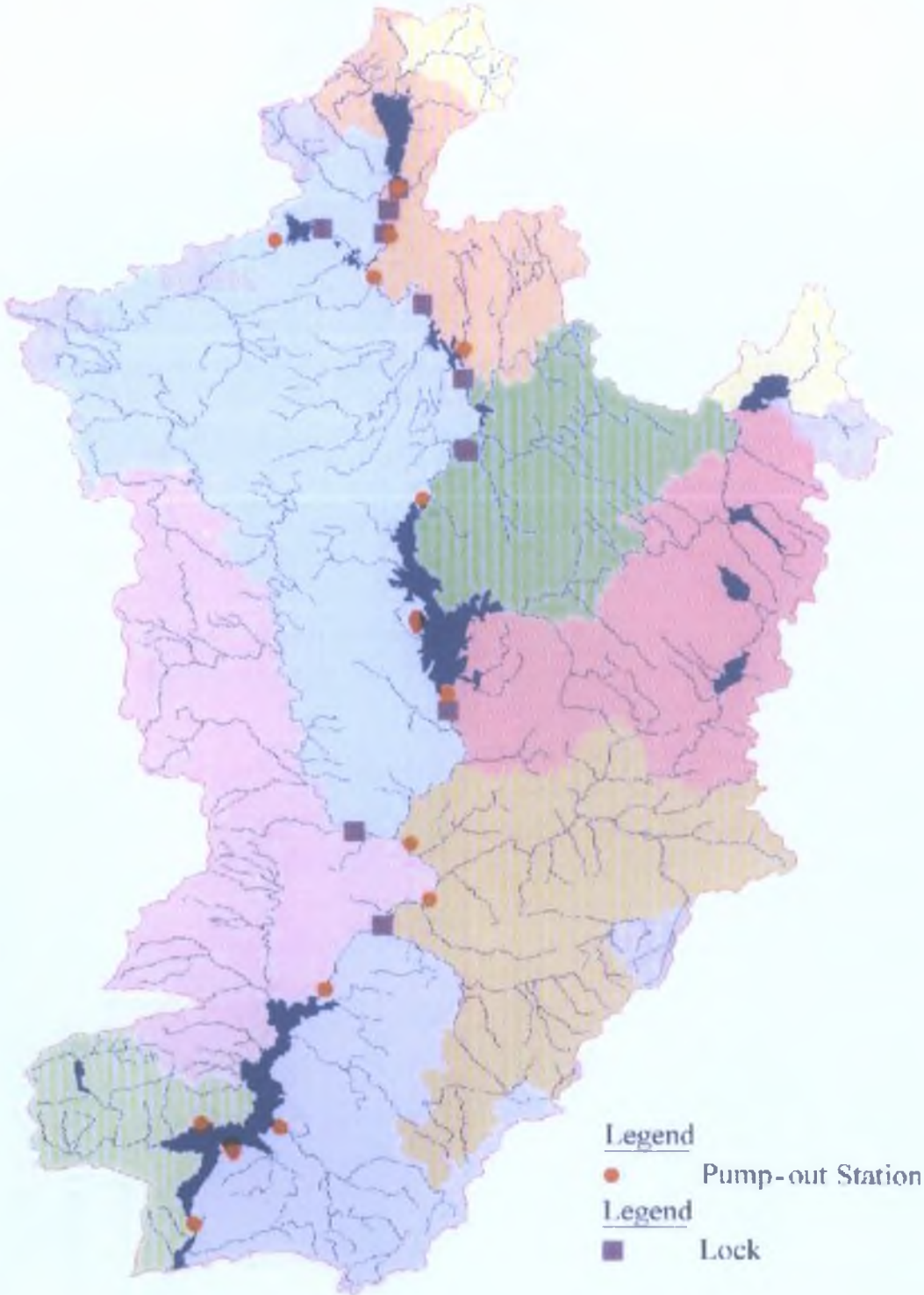

Figure 5 Pump-out Stations within the Shannon Navigation Jurisdiction

(Source: Kirk McClure Morton, 2001, adapted)

Table 2.14 Pump-out Stations on the Shannon- Erne and Shannon Navigation (R.O.I):

LOCATION	NAVIGATION SYSTEM	COUNTY	PAY MODE	MANAGED BY
Ballyconnell	*Shannon-Erne*	*Cavan*	*Smart Card*	*W. I.*
Haughton's Shore	*Shannon-Erne*	*Leitrim*	*Smart Card*	*W. I.*
Ballinamore	*Shannon-Erne*	*Leitrim*	*Smart Card*	*W. I.*
Keshcarrigan	*Shannon-Erne*	*Leitrim*	*Smart Card*	*W. I.*
Leitrim Village	Shannon Nav'n	Leitrim	Smart Card	W. I.
Drumshanbo	Shannon Nav'n	Leitrim	Smart Card	W. I.
Ck –on-Shannon	Shannon Nav'n	Leitrim	Smart Card	Co. Council
Dromod	Shannon Nav'n	Leitrim	Smart Card	Co. Council
Drum Bridge	Shannon Nav'n	Roscommon	Smart Card	W.I.
Ballyleague	Shannon Nav'n	Roscommon	Operative	Co. Council
Lecarrow	Shannon Nav'n	Roscommon	Smart Card	W. I.
Athlone	Shannon Nav'n	Westmeath	Operative	Co. Council
Shannonbridge	Shannon Nav'n	Offaly	Operative	Co. Council
Portumna	Shannon Nav'n	Galway	Smart Card	Co. Council
Mountshannon	Shannon Nav'n	Clare	Smart Card	Co. Council
Garrykennedy	Shannon Nav'n	Tipperary N	Smart Card	W. I.
Dromineer	Shannon Nav'n	Tipperary N	Smart Card	Co. Council
Killaloe	Shannon Nav'n	Tipperary N	Smart Card	Co. Council

(Source: Waterways Ireland)

The distances between Pump-out Stations is a key issue when considering the sustainability of the pollution prevention programme.

Table 2.15 Average Cruising Hours between some Pump-out Facilities

Direct Trip at ~ 6 knots per hour	**Cruising Hours**
Carrick- on - Shannon to Dromod	2 hours
Dromod to Lanesboro	4 hours
Lanesboro to Athlone	3 hours
Lanesboro to Lecarrow	2 hours
Athlone to Shannonbridge	2 hours
Athlone to Banagher	4 hours
Athlone to Portumna	4 hours
Portumna to Scarrif	4 hours
Scarrif to Killaloe	2 hours

2.3.4 On-shore Toilet facilities

Pollution associated with marina activity is complex. A synergistic effect of the release of hydrocarbons and sewage is probable. The use of sea toilets in the marina exposes the aquatic environment to impoverished water quality. Marinas tend to be established in sheltered areas of the lakes or river, where natural current is reduced, thus the build up of offending matter is common. Faecal coliforms in lake water are predominantly

removed by adsorption onto particles and subsequent sedimentation. Thus, viable coliform bacteria usually accumulate with sediment (Gannon *et al.*, 1983). The cumulative effect of long term storage of vessels at marinas is further complicated by the resuspension of sediments harbouring faecal bacteria caused by the churning of water associated with boating activities (Yonn-Joo, 2002).

The closure of service block in the absence of a warden is common at marinas. Many moorings and boatsheds do not provide services such as hygiene facilities (and corresponding sewage management), waste facilities, etc. To presume dogmatically that marinas, moorings and boatsheds are sources of polluting matter would be erroneous, but to ignore the possibility would be folly. Where on-shore toilet facilities are unavailable or unkempt, the use of on-board toilet facilities is an obvious consequence. Control of Marina standards is left to owner discretion. There is no Code of Practice developed by the EPA, though the Irish Marina Federation (limited membership, many coastal marinas) upholds good practice. Best International Practice requires that a commercial marina would be equipped with pump-out services and dump stations for chemical and dry toilets. The Office of Wetlands, Oceans and Watersheds of the USEPA provides guidelines for Marina Operators and Boaters regarding design of marinas, including sewage management (USEPA, 2003). Furthers management of sewage if stored in the Marina is outlined in the technical guidance document which includes preventative measures regarding design and management of marina basins and banks in order to prevent run-off and leachate to waters (USEPA, 2003). The Scottish EPA produced the Pollution Prevention Guidelines (PPG 14) for the UK marinas and boaters.

In Ireland, recent development of marinas is controlled, but land planners claim to lack expertise in the specialised requirements of construction. Local authorities are positively predisposed to such development proposals, to maximise the socio-economic benefits of the navigation in their jurisdiction (The Heritage Council of Ireland, 2006).

An Taisce was formed in 1948 but gained statutory recognition via the Planning laws of 1963. An Taisce promotes good Marina practice via the international Blue Flag Programme. The programme encourages Marina owners to adhere to an environmental code of conduct. There are 19 imperative and 4 guideline criteria to be considered, including bilge and toilet pumping facility and that sanitary facilities are well kept. The award is judged by a panel and applications must be renewed annually. There is only one marina on the Shannon Inland Waterway with Blue Flag status, at Killinure Point on Lough Ree.

Older marinas are often not registered with the local authority. There are numerous private moorings that are not marked on any navigational chart, but are discovered only when in transit, or on the recommendation of a local resident. The registration of older commercial moorings and marinas may be complicated by many factors: construction may have occurred chronologically prior to legislation, provisionality, disputes over rights-of-way, etc. Anecdotal evidence supports the suggestion that many authorities are not aware of the existence of indigenous cruiser micro-enterprise within their jurisdictions.

2.4 Factors Effecting Pollution Load

Sewage from cabin cruisers differs from domestic sewage arriving at a waste water treatment plant in several ways:

- Flushing water is limited
- It is released into the receiving water at body temperature (~37°C)
- It is not macerated during transportation through a system
- The sewage has not been stored.

However, the sewage load comprises of a 70:30 organic: inorganic ratio.

The organic portion contains

- 65% protein
- 25% carbohydrate and
- 10% fats.

By products from the breakdown of these compounds (C, H, O, S, P, N compounds) are released directly into the water. There are no waste water treatment purification processes to remove parameter excess as required by the Urban Waste Water Directive, 1991.

Biodegradability depends largely on C:N:P ratio, which in "common" raw sewage is 100:17:5, but should ideally be 100:5:1.

2.4.1 Pharmaceutical and Personal Care Products (PCPPs)

For several years, the addition of pharmaceutical products to the aquatic environment has been a worrying factor. Where the effluent passes through a water treatment system, there is evidence that these substances may inhibit the processes which detoxify the waste. With regard to sewage containing PCPPs which may reach surface waters directly from cabin cruisers, the outcome is unmeasured, but cumulatively serious. The active ingredients are readily available to aquatic organisms in the environment. There is also the risk of these substances re-entering the human food chain via municipal water systems.

Table 2.16 Common PCPPs occurring in wastewater and lowland rivers (non-exhaustive list):

Analgesic/ anti-inflammatory effect: **Acetylsalicylic acid, Carbamazepine, Carboxyibuprofen, Diclofenac, Hydroxyibuprofen, Ibuprofen, Naproxen.**
Psychomotor stimulant effect: **Caffeine.**
Antibiotic effect: **Chloramphenicol, Ciprifloxacin, Erythromycin, Norflozacin, Trimethoprim.**
Lipid reducing effect: **Clofibric Acid**
Psychiatric (anti-depressant effect): **Diezepam**
Hormone (Estrogenic effect): **17ß-estradiol, Estrol, Estron, Nonylphenol.**
Anti-epilectic effect: **Primidone,** Sulphonamides: **Sulphadizine, Sulphomethoxazole, Sulphonamides varied.**
Multi-purpose effect: **Salicylic acid**

(Adapted from Gray, 2005)

Some of these substances are endocrine disrupters; many are not regulated under the EU Dangerous Substances Directive of 1976. Fragrances, vitamins (water and fat soluble) and generic dyes used in PCPPs are all complex substances, many synthetic. These are not included in the list. Ozonation, chlorination and activated carbon absorption are required to remove these elements from wastewater.

2.4.2 Detergents

The term "detergent" refers to cleaning agents, usually of a non-soap variety. Since 1960, worldwide usage of detergents has multiplied tenfold.

Table 2.17 Components of typical detergents

Chemical Function	Typical Ingredient	Proportion (%)
Surfactant	LAS	3-15
Builder	Sodium Tripolyphosphate	0-30
Ion exchanger	Zeolite type A	0-25
Anti-redeposition Agent	Polycarboxylic acids	0-4
Bleaching Agent	Sodium Perborate	15-35
Bleach Stabiliser	Phosphonate	0.2-1.0
Foam Booster	Ethanolomide	1-5
Enzyme	Protease	0.3-1.0
Optical Brightener	Pyrazolan Derivatives	0.1-1.0
Corrosion Inhibitor	Sodium Silicate	2-7
Fragrance	various	0.05-0.3

(Hunter *et al.*, 1988)

In 1965 a ban on alkyl-benzene-sulphonate foaming agents was introduced. These were replaced by linear alkylate-sulphonate (LAS) detergents. Polyphosphate compounds were added to increase the efficiency of these agents, mostly in the form of tripolyphosphate. It is estimated that 70% of the municipal orthophosphate load originates in detergents and household cleaning products (Gray, 2005). Small amounts of these nutrients reach receiving waters from cabin cruisers as toilet cleaning agents, and obviously add to eutrophication of surface waters.

2.4.3 Impacts on Water Quality

Qualitative changes in water quality as a result of sewage pollution can be sourced to the following factors:

Pathogens: The introduction of enteric micro-organisms and natural microbes to the aquatic environment will affect the amount of dissolved oxygen use, in particular. All micro-organisms are chemists and will break down organic matter to smaller elements, creating many of the conditions mentioned below. An increase in pathogens will create a competitive climate, whereby the dominant organisms flourish, upsetting the ecological balance.

Increase in Suspended Solids: Increased particle matter is the cause of cloudiness, thus reducing light penetration and originating accumulation of debris on fish gills leading to respiratory difficulties.

Toxic Substances: Generally heavy metals or trace organic substances which are poisonous to aquatic organisms. They may be bioaccumulative and pass upwards through the food chain. Some substances may exert a synergistic effect.

Temperature: Water temperature is one of the physical regulators of biodiversity. Organisms are sensitive to changes in temperature and will flourish or degenerate according to the conditions provided in the immediate habitat

Non- Toxic Salts: The introduction of non-toxic salts will augment the ionic state of the water.

pH: Changes in acidity directly affect the viability of aquatic organisms.

2.4.4 Deoxygenation

When the organic load to water is excessive, micro-organisms will use available oxygen to release energy from the food source. When the chemical reactivity of the water is high due to increased ionic strength or changes in pH, the dissolved oxygen in the water will be scoured. Deoxygenation of water created anaerobic conditions where only anaerobes or facultative micro-organisms can thrive. Water which is stripped of oxygen quickly becomes foul and results in the death of oxygen dependent organisms.

Measuring Deoxygenation: The BOD_5 quantatively measures the biodegradability of an organic load over a five day period under constant conditions of 20°C. It is useful when comparing the water quality of samples.

2.4.5 Eutrophication

Eutrophication is caused by over enrichment of the waters with nutrients, in particular nitrates and phosphates. A greening of the top layers of the water is typical, with a dense slime being formed from the surface of the water downwards. Under the scum, light cannot penetrate and oxygen depletion is common. Few aquatic organisms can survive

the change in conditions and death of the creatures making up the habitat soon follows. Eutrophication is presently one of the most important threats to water quality in Ireland. The introduction of sewage to water is a precursor of this condition. Remedy for eutrophication, as for deoxygenation is slow, and often occurs too late.

Measuring Enrichment causing Eutrophication: Many indicators can be utilised, but for the purposes of this investigation a simple calculation of the phosphate load is adequate.

2.4.6 Remedy for deoxygenation and eutrophication

Both of these conditions depend on regeneration of water quality to improve living conditions for those organisms indigenous to the medium. Currents or large increments in volume constitute a natural remedy. Often the remedy within natural habitats can take a change in season, sometimes a year or years if the offending load is not removed.

3.0 Stakeholder Participation

The layered nature of the legal requirements and the crossover of the various stakeholder interests and authority briefs created a conundrum. The related hierarchical structure of pertinent authorities is largely egalitarian (Local Authorities, Waterways Ireland, Regional Fisheries Boards, etc). The EPA is the supreme environmental authority within the State. The eighteen local authorities within the catchment area have equal status, as do the three water based authorities. The Shannon River Basin District formed under the Water Framework Directive has a management and reporting brief, it is not an authority.

3.1 The Environmental Protection Agency

Based in Co. Wexford with regional offices, the EPA has the brief of assuring compliance in all Irish environmental matters. The EPA was created as the National Authority under the Environmental Protection Act of 1992, and was later selected as the pertinent National Authority under the Water Framework Directive.

The EPA does not have a brief regarding marinas, and have not yet written a Code of Practice for either marinas or cabin cruisers. The EPA monitors national water quality in conjunction with the local authorities. The sample points do not coincide specifically with marina or public harbour activity, though some sampling points do coincide downstream of waste water treatment plants that are located close to municipal activity with a harbour or marina. Thus no precise data can be obtained from annual sampling data.

3.2 Planning Authorities

There are 26 Planning Authorities with jurisdiction within the SRBD catchment area. Eighteen of these are County Councils, the remainder Town Councils. The Planning Authorities administer the Planning and Development Acts of 1963 and 2000. The Water Management Plans required under the Water Pollution Act of 1977 must be adhered to.

3.3 Environmental Departments of the Local Authorities

The environmental departments of the Local Authorities are guardians of water quality as outlined in the Water Pollution Acts of 1977-90. Of particular interest, Section 12 of the Water Pollution Act of 1977 requires the proactive prevention of a polluting incident. In 2003, Leitrim County Council served a section 12 notice on the various rental companies in the area. The companies appealed the decision, deeming that it would make them uncompetitive and that in other jurisdictions, no demands had been made. The Local Authority deferred the order temporarily. Following collaboration with other local authorities, section 12 notices were enforced on several of the rental companies on the entire river. It is reported that prior to the 2008 season, many of the businesses can now claim to be compliant.

All of the Environmental Departments of the Local Authorities adjacent to the Shannon manage points of abstraction of drinking water along the river.

3.4 Department of the Environment, Heritage and Local Government

The DoEHLG supports projects that will enhance the protection of the environment. Since the publication of The Shannon Navigation (Construction of Vessels) (Amendment) Bye-Laws of 1994 (S.I. 421 of 1994), the Department has provided grant aid for the construction of related built environment, pump-out stations are largely funded by this department. There is no statutory requirement for the provision of pump-out stations, and no common specification has been established nationally.

3.5 Waterways Ireland and Shannon Navigation

Waterways Ireland has the task of maintaining and developing the built environment and amenity value of the inland waterways throughout the seven navigational systems throughout the island of Ireland. Shannon Navigation is the legal guardian of the navigable Shannon. The national organisation takes a proactive role in the care of the Shannon waterways; but there are gaps in the system, however. Funding is largely diverted to the renovation of the Ulster Canal, currently underway. The notorious "legal brief" sometimes conceals the intersection of interests or sluggish progress creates major difficulties. The bureaucracy involved in every project is genuinely laborious. Waterways Ireland manages approximately 70 public harbours and jetties along the Shannon Navigation. They do not have any remit regarding private marinas. The organisation often collaborates with local authorities and The Heritage Council and occasionally with the Fisheries Board.

Shannon Navigation is heavily burdened. There are two inspectors employed to enforce legislation on the river. The inspectory role covers 8, 000 registered vessels, propelled

sports craft of less than 15 horsepower and other craft propelled by human force. Thus enforcement is problematical due to lack of personnel. The inspectorate inspected 38 vessels in 2006 and 40 in 2007. They do not distinguish between private and rental vessels. They found all vessels inspected to be compliant to S.I. No 421 of 1994. When asked about the "Y" valve, the response was ambiguous. Because the boats do not exclusively travel in the freshwater Shannon, the requirement to seal the system cannot be enforced. There is no history of court cases involving S.I. 421 of 1994.

3.6 The Shannon Regional Fisheries Board

The SRFB is the custodian of water quality relating to the preservation of fish stocks, as endorsed by the Fisheries Acts of 1959-83. There are two environmental officers engaged in the prevention of pollution throughout the Shannon. To date, no monitoring of environmental management at rental companies or marinas has taken place and no legal cases have arisen from marina activity. Section 171 and 172 of the Fisheries (Consolidation) Act of 1959 has been enforced widely on sectors such as industry and agriculture. Many legal cases won using the "permit or cause to fall to water" clause of s 171. Only once has there been a custodial sentence resulting from s 172, and this was later retracted following appeal. Though the Authority admits that there is reason for preoccupation, sections 171 and 172 have never been used to avert pollution from boats, rental companies or marinas. Fish kills are regular, and sourcing pollution is complicated. The use and storage of leisure craft is becoming increasingly suspect as the numbers of vessels augment.

The senior Environmental Officer with the SRFB confirms that the two sections could be very well employed in controlling pollution from the sector. The Board is currently writing a Code of Practice for marinas, and plans to implement stricter controls as required by sections 171 and 172 of the Act.

Collaboration with other bodies is uncommon, unless for issues relating to participation in the Shannon River Basin District Plan.

3.7 Fáilte Ireland

The Irish Tourist Promotion body supports a sector that brings €70 million to the Shannon Region every year. In conjunction with the Irish Boat Rental Association, the body plans to write a Code of Practice for the sector. At present, rental companies promote environmental issues to their clients prior to releasing the boats.

3.8 The Inland Waterway Association of Ireland

This voluntary organisation is extensively involved in the creation of sustainable conditions for boaters and other river users. The association heavily endorses responsible behaviour among cruiser owners. Recent lobbies have highlighted the condition of on-shore sewage provisions, which the organisation believes to be inadequate. While promoting environmental issues, a protective attitude regarding member compliance is evident; the organisation insists that compliance is complex under the present conditions. Their quarterly publication routinely contains an article of sewage concerns. Attempts to speak with a representative of the voluntary association have been unproductive.

3.9 The Heritage Council of Ireland

The council are heavily engaged in the protection of the Shannon waterway and its environs. The agency remit is that of protecting cultural and built heritage. Over a period of six years, the organization has produced in-depth corridor studies. The studies treat aesthetical issues and the underlying environmental causes. The documents are comprehensive; the most recent studies include a Strategic Environmental Assessment as required by European Communities (Environmental Assessment of certain Plans and Programmes) Regulations of 2004 (S.I. No 435 of 2004).

3.10 An Taisce

An Taisce has statutory status since the publication of the Planning Act of 1963. The organisation has a dual role; it is the guardian of the environment and has an educational role. As guardian of the environment, An Taisce will lobby for sustainable practice in any sector. As part of its educational role, in conjunction with the European Foundation for Environmental Education (FEE), An Taisce, supported by the DoEHLG manage the Blue Flag scheme. The marina Blue Flag is inspected and must be annually sought. The Blue Flag for boaters is administered following the signing of a code of conduct. Response to both the water related schemes is slow. Promotion is poor, being significantly less supported than the Blue Flag for beaches, the Green Schools Programme and the novel Green Homes Programme.

3.11 The Office of Public Works

Prior to the creation of Waterways Ireland "Inland Waterways" of the OPW held the brief within the Republic of Ireland. It was under the OPW that the first pump-out stations were built, funded by the DoELG. The installation of a Sykes vacuum pump leading directly to sewer was universally adopted. The Water Services Department staff of the OPW are not aware of any written specification and a search to find such documentation has proven ineffective.

4.0: Methodology: Data Collection and Statistical Analysis

The literature review highlighted the multilateral nature of compliance. Authority reports reflect that current compliance status is inconsistent, and that variable factors lead to these inconsistencies. The selection of research methods should systematically verify this hypothesis, so far as is practicable.

Research Objectives

The aims of the research process included:

1. To ascertain the current application of legislation.
2. To determine the current status of on-shore installations
3. To quantify compliance vis-à-vis on-board toilet facilities
4. To quantify compliance/ non- compliance
5. To identify difficulties regarding the achievement of compliance.

4.1 Selection of Methodology

Research method selection must permit the non-biased collection of empirical data from various sources. A sample of the cruiser population was required. The method would have to be flexible enough to overcome the limitations of the respondent characteristics, which included rental and private cruiser users. Following evaluation, the method selected in order to attain pragmatic data was the questionnaire. A survey of vessel and voyage data would provide objective background information via closed questions (quantitative data) and one open question to allow the participants to air grievances (some recalcitrant) (Appendix II)

Reference Materials

Designing the questionnaire involved the formulation of questions which met the research objectives. For the questionnaire both legislation and best practice were referred to.

Selected Respondents

Cruiser population representatives: Hire boats and Private boats

Access to respondents

Access to cruiser population is tedious. A web poll could have reached some of the interested parties but may have given unreliable results. The cruiser population were believed to be circumstantially unfocused. A balance between private and rental boat users was desirable. Following evaluation, it was decided to survey the cruiser population while in transit, in one of the locks that make up the navigational system. For logistical reasons Rooskey Lock was chosen. This mode also permitted the cross-referencing of previously sourced data such as annual lock passages, person days, etc.

Sample Size and Factors Conditioning Selection

Cruiser population representation was restricted to the first one hundred boats to successively pass Rooskey Lock on the May Bank Holiday weekend. Weather conditions had to be carefully assessed and would have a direct outcome on the success of the exercise. To facilitate communication, ideally respondents would be available on deck. In bad weather, boaters remain behind canvas covers or sliding windows. The navigational season begins on the first day of April and ends on the last day of October, with exceptions either end. High winds did not permit boating prior to the selected date.

Permission

The questionnaire and survey process clearly required the collaboration of the Lock-keepers. Written permission was sought from Waterways Ireland in order to carry out the study on their territory and in co-ordination with the Lock-keepers. The Lock area was adequately signed with notices advising boaters of the non-obligatory and purely academic nature of the Survey (Appendix II)

Confidentiality

Each participant was punctually briefed regarding the purpose of the data collection. The data compiled was guaranteed to be used only for the academic study. No identification codes or numbers were required from the contributors. Participants could decide to reverse their decision to participate at any time (Appendix II).

4.2 Estimating Pollution Load

Estimating pollution load from Cabin Cruisers is difficult. Parameters such as population equivalents (p.e.) are not fully reflective of the load. A population equivalent factors in domestic sewage along with trade, hospital or other sectoral wastewater reaching a Waste Water Treatment Plant.

A reasonable means of estimating pollution load to water is to determine the number of person days that are spent on the river, on vessels which can discharge to water.

4.3 Adopting Parameters

The Waste Water Discharge (Authorisation) Regulations, 2007 adopt a Population Equivalent (p.e.) (BOD_5) equal to 60g of oxygen. This factor, multiplied by the number

of person day on the Shannon should give a simulated BOD_5 load. Other calculations can be made regarding, for example, phosphorous. It is estimated that a person produces 2.7g of phosphorous per day. 70% of this P load is attributed to orthophosphates associated with detergents (Gray, 2005). For the purposes of calculating the sewage P load a more conservative figure of 0.8g may be prudent. This factor, multiplied by the person days spent on the Shannon should give a phosphorous load.

4.4 Piloting

In order to verify comprehension of questions and lack of bias, a sample of the questionnaire was proof-read by three practitioners and piloted on ten acquainted cruiser owners who were invited to constructively criticise the document.

Issues under scrutiny while piloting include:

- Accuracy of the question – will the question collect the required information?
- Is the language free of bias and ambiguity?
- Is the format logically structured, is it user-friendly?

Modifications were made as considered necessary.

4.5 Limitations of the Research Method

Direct Access tends to assure comprehension of the topic under surveillance, but it also provides the opportunity to introduce interpretive style. It is important to have one person only carrying out the surveys in order to limit individual differences of

expression. The surveyor must be disciplined and procure not to introduce bias by emphasising certain aspects.

Following consultation with the Lock-keepers, a three day permit was sought and granted from Waterways Ireland for the entire cruiser population survey. The frequency of boats can, at best, be estimated and could not be guaranteed. It was hoped that three days would be sufficient.

Language and Cultural differences among boaters vary. Many visitors are foreign and may have a restricted use of English, Irish boaters demonstrate a broad cultural disparity. Time management at the location was of prime importance; the length of survey was conditioned by:

- The length of time the lock sluices require to re-align the levels of water; approximately fifteen minutes.
- The number of boats in each lock enclosure; generally limited to a maximum of four boats
- The Lock-keeper's task
- Boater approval of the survey and respect for the leisure time of the crew

The questionnaire probed some sensitive issues, thus the approach prior to commencing the enquiry was of prime importance.

4.6 Length of Time required to Complete Questionnaire

Respondents were not limited to any timeframe, although the questionnaire was designed to be completed in approximately three minutes, following briefing. This timeframe was conditioned by the limitations outlined above.

4.7 Statistical Data Analysis Tool

For the purposes of this study, Microsoft® Excel® 2003 was the most suitable package.

4.8 Summary

Table 4.1 Summary relating to Selected Sample

SAMPLE	Cruiser Population in transit 3rd, 4th and 5th May, 2008
Sample Number	100 boats
Sample Selection	Random, conditioned by convergence at Lock
Limiting Factor/ reason for choice of number	Representative number of cruisers punctually in transit
Distribution	Direct Access
Time Limitation for Response	As required by respondent
Person to whom the Questionnaire was directed	Captain/ skipper
Factors affecting time allowance	Lock sluice and gate requirements (~ 15 minutes) Number of boats in enclosure Boater attitude and acceptance of survey The lock-keeper's task
Factors affecting response	Language variation Sensitivity of topic Prevailing weather
Precision of data analysis	Good. Percentages of n = 100 are precise.

4.9 Design Objectives of Questionnaire

4.9.1 Title: "Questionnaire: Provision of sewage services along the River Shannon"

The questionnaire was labelled "Provision of sewage services along the River Shannon". The title refers to on-shore facilities and avoids sensitive issues such as corresponding on-board toilet installation. The respondent is only asked about boat installation in the final sub-question of the survey.

In writing a question, awareness of the precise information sought or expected replies is a primary requirement.

4.9.2 Re Question 1

1. **Does your boat require the use of Pump-out Stations along the Shannon?**

   Yes ☐ No ☐

This question centres the participants' attention on the pump-out stations. In the case of private craft, this question clarifies indirectly whether or not the cruiser has a holding tank, though the participant is concentrating on corresponding on-shore facilities. In the case of hire boats, further clarification is required, as depending on the length of the trip, the users may not require to use the pump-out facilities. If the boat has a holding tank, the "yes" option is adopted.

4.9.3 Re Question 2

2. **Do you think that pollution prevention on the Shannon is important?**

Yes ☐ No ☐

This question endeavours to quantify in some way the number of persons who are focused on pollution issues. Boaters may have a very definite opinion about the provisions made for the prevention of pollution on the Shannon. Indeed, many private boat owners will not convert their boats until further provision is assured. Other users, particularly rental users, might not be focused on pollution issues.

4.9.4 Re Question 3

3. **What are the problems encountered?** (tick as appropriate)

Insufficient Pump-out Stations ☐
Pump-out Station out of order ☐
Pump-out Station in unhygienic conditions ☐
Mooring close to Pump-out Station not available ☐
Smart-card difficulties ☐
System difficult to use ☐

Other/s .....

This enquiry gives the respondent a list of typical problems that may be encountered or envisaged. Only boaters requiring the use of pump-out stations were invited to answer this question. The "other/s" space gives the participant the option of alternatives.

4.9.5 Re: Question 4

4. **Is there other information that you believe to be of importance to my research?**

.....

This question invites the participant to add something of personal value to the investigation. Many river users have in-depth knowledge of the difficulties encountered by themselves and others. Many can give valid solutions to the problems encountered.

4.9.6 Re: Vessel and Voyage Survey

Table 4.2 Vessel and Voyage Data Survey

Vessel and Voyage Data:
Private vessel ☐ *Hired vessel* ☐
Approximate year of manufacture ..... *Length in feet* .....
No. of berths: ..... *No. of persons on board today* .....
Length of voyage: From : ..... *To:* .....
How long do you plan to cruise for? ..... *days*
Toilet installation: Sea toilet ☐ *Holding tank* ☐ *Chemical* ☐

The Vessel and Voyage survey shifts the attention from the on-shore facilities to the boat. While the questionnaire enquired about current opinion or experience, the survey collected data on current boat status and trip data only. This data was required to

validate the questionnaire data against existing Waterways Ireland data, and further develop boat statistics. Boat passages from previous seasons provide data for comparison.

The ratio of private vessels in comparison to hired vessels is of importance. The survey will be consistent with Waterways Ireland data if an approximate 1:1 ratio of private to rental boats exists for weekend traffic. An overall ratio of 1:2 is consistent with 7 day traffic as there are less private boats during the week.

The year of manufacture may clarify the assumption that all old boats pollute and new boats are compliant. The length of the boat is only of value when estimating required mooring spaces at pump-out stations.

The number of berths gives the maximum number of persons that a boat can hold, and as such, the maximum possible person-days should full berth capacity have been used. The number of persons on board gives the exact number of person-days corresponding to the 100 boats surveyed. From this data, pollution impact per 100 boats can be estimated.

The distance of the voyage can be cross-referenced to the average cruising times between Pump-out Stations.

The last sub-question is the most sensitive enquiry. Participants are asked about on-board toilet installation.

Participants were asked about the length of their voyage in days. This, when cross-referenced with persons on board gives collective person-days per trip and per 100 boats. This data, when multiplied by a BOD factor or Phosphate factor can give cumulative pollution-to-river data created by a sample of 100 boats.

4.10 Response

One skipper refused to participate in the survey. This was compensated for by the addition of one more boat to the numbers surveyed, thus the required 100 responses were achieved.

All other skippers approached were positive about participation, and gave data generously.

Five crews had language difficulties, which were overcome following articulation. This was not considered to influence data collection.

There were no adverse reactions to sensitive questions. Good humour prevailed.

4.10.1 Factors conditioning Response

Prevailing Weather Conditions

Sunny weather prevailed throughout the three days of the survey. On the first day force three winds affected navigation in the late afternoon. It was not felt that this affected the outcome of the survey.

Co-operation of Lock-keepers

The Lock-keepers were sympathetic to the requirements of the survey, though they could not be seen to participate in the mechanism. While maintaining clarity regarding the non-official nature of the process, conditions were astutely created to enhance collaboration from boaters.

4.10.2 Validity and Reliability of Data

The ratio of 1:1 private: rental boats (Table 5.1) which was evident was unusual for early season data. The first one hundred boats to pass through the Locks were surveyed, return passages were not surveyed. The number of Lock Passages on the survey days was comparable to a peak season weekend.

Table 4.3 Total Lock Passages on days of Survey:

	Total Number Lock Passages	**Upstream**	**Downstream**
3rd May 2008	45	15	30
4th May 2008	56	34	22
5th May 2008	54	32	22

Table 4.4 May Bank Holiday Lock Passages, a comparison

	1998	**2007**	**2008**
Saturday	43	70	45
Sunday	38	63	56
Monday	47	46	54

(Source: Waterways Ireland, 2008)

The average annual data for the May Bank Holiday weekend is 154 Lock Passages. The 2008 data reflects an average number of Lock Passages for a normal May Bank Holiday weekend traffic.

Total Lock Passages for May 2008 amounted to 912 with private boats numbering 244. Weekend traffic tends to be equally distributed between private and rental boats, whereas annual 7 day data gives a 1:2 ratio between the two sectors.

5.0: Questionnaire Results

All the data collected relates to one hundred Lock-passages through Rooskey Locks on May 3rd, 4th and 5th of 2008. One hundred skippers were questioned on their requirements regarding the provision and use of Pump-out Stations along the navigable freshwater Shannon.

5.1 Results for Question 1

Table 5.1 Proportion of boats requiring the use of Pump-out Stations

Question 1	answer		percentage
Does your boat require the use of Pump-out Stations along the Shannon?	yes	64	64%
	no	36	36%

An almost 60:40 split was recorded between those requiring the use of a pump-out station and those who do not. This data reflects the on-shore requirements of both private and rental sectors.

5.2 Results for Question 2

Table 5.2 Attitude of boaters to pollution prevention on Shannon

Question 2	answer		percentage
Do you think that pollution prevention on the Shannon is important?	yes	86	86%
	no opinion	14	14%

The majority of boaters express an opinion about the prevention of pollution on the Shannon, 5 persons out of six of those surveyed replied positively. A positive answer suggests a focused attitude to pollution on the Shannon.

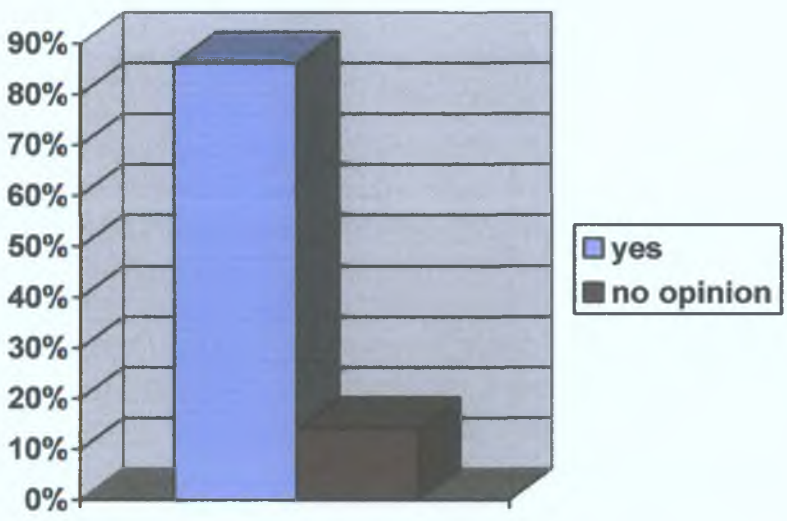

Figure 6 Importance of Pollution Prevention on the Shannon

5.3 Results for Question 3

The response indicated that the biggest problem encountered was the lack of sufficient infrastructure regarding the provision of pump-out stations. 36 out of 61 skippers requiring the use of pump-out stations found this to be problematic. 54% of skippers found that the administration of the harbour area was insufficient; mooring was not available. One third of users found that the pump-out stations were out of order. 15% of users found the pump-out stations were in unhygienic conditions, demonstrating a lack of maintenance

Table 5.3 Problems encountered with use of Pump-out Stations

Question 3: What are the problems encountered? (tick as appropriate)	(n = 61)	%
Insufficient Pump-out Stations	36	**59%**
Pump-out Station out of order	20	**33%**
Pump-out Station in unhygienic conditions	9	**15%**
Mooring close to Pump-out Station not available	33	**54%**
Smart-card difficulties	4	**7%**
System difficult to use	13	**21%**
Other/s	0	0%

One fifth of the population requiring the use of pump-out stations found the system difficult to use; this may be an individual complication, or a mixture of all the previously listed problems. A minority of users encountered Smart Card problems.

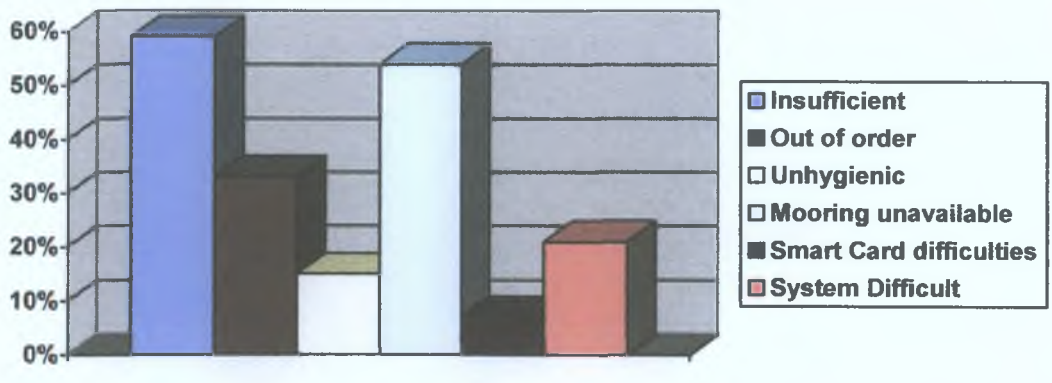

Figure 7 The problems encountered with Pump-out Stations

5.4 Results for Question 4

Is there other information that you believe to be of importance to my research?

Table 5.4 Additional Information of Importance

Question 4: **Is there other information that you believe to be of importance to my research?**	
Compilation of non-spurious answers	**incidence**
Lough Ree is badly catered for. The Lough Derg Region is well catered for	**3x**
Every private marina should have a pump-out facility	**7x**
Winter opening hours should be organised for post and pre-season trips	**2x**
Some pump-out stations are non-functional during periods of high or low water levels	**2x**
Pump-out service too expensive, especially for small holding tank	**1x**
Holding tank always emptied to lakes	**8x**
No sign of enforcement	**12x**
Leakage from holding tank caused smells (gases)	**4x**
Distance between Pump-out Stations too much, tank emptied to water if facility not available	**15x**
Boats availing of Winter mooring at Public Harbours should be restricted as they occupy access to Pump-out Station	**3x**
Have holding tank, refuse to use pump-out until more provision made	**7x**
Use of holding tank requires in-depth flushing to avoid corrosion, provision insufficient.	
Could have environmental impact on water use	**3x**
Shannon- Erne Waterway is exemplary	**5x**
Holding Tank installed, no knowledge of how to empty it (all rental boat crew)	**43x**
Tank not emptied by rental company	**3x**

This open question was enthusiastically received. It gave the participants the opportunity to spontaneously add elements of their own experience to the investigation. Some answers were not related to the topic and have been omitted from the compilation of responses.

These additions cannot be interpreted in the present study, but many support the theories under investigation. The responses provided some valuable information regarding current practice of river users.

5.5 Results of Vessel and Voyage Survey

Ratio of Private to Rental Boats

The first enquiry in the survey was related to the ratio of private to rental boats. The data showed an almost 50/50 split between the two sectors:

Table 5.5 Correlation of private to rental boats

Vessel Ownership	Private	Hire Company
	49	51

Year of Manufacture of Vessels

The year of manufacture of the vessel was the subject matter of the second query. Boat age is not always known, particularly if the vessel has changed hands. In many cases, the age of manufacture of vessels is estimated using specialist knowledge of model and type

more than date of registry. Within the manufacturing era of a certain model, original installations may be used to verify the vintage, for example, the brand of boiler, cooker or even the use of Formica® in the interior. Many persons who hire boats are oblivious to boat age. For these reasons boat age has been correlated to a decade rather than a year. Patterns evolved regarding the vintage of boats and ownership. All of the rental boats are relatively new, being manufactured from the 1980s onward. Private boats ranged from the ancient steel Grand Canal Company barges (valued at ~£850.00 in 1880) to high tech "Princess" yachts worth some €0.5 Million. Thus, construction date of vessels in transit varied from the 1920s for the heritage boats (converted barges) up to 2007 for some of the more affluent vessels.

Table 5.6 Decade of Manufacture of Vessels in Transit

Decade of Manufacture of Vessel	**No.**	**% Total**	**Private**	**Rental**
1920s	2	2%	2	-
1930s	1	1%	1	-
1940s	-	-	-	-
1950s	-	-	-	-
1960s	1	1%	1	-
1970s	15	15%	15	-
1980s	26	26%	19	7
1990s	35	35%	8	27
2000s	20	20%	5	15
Total	100	100%	51	49

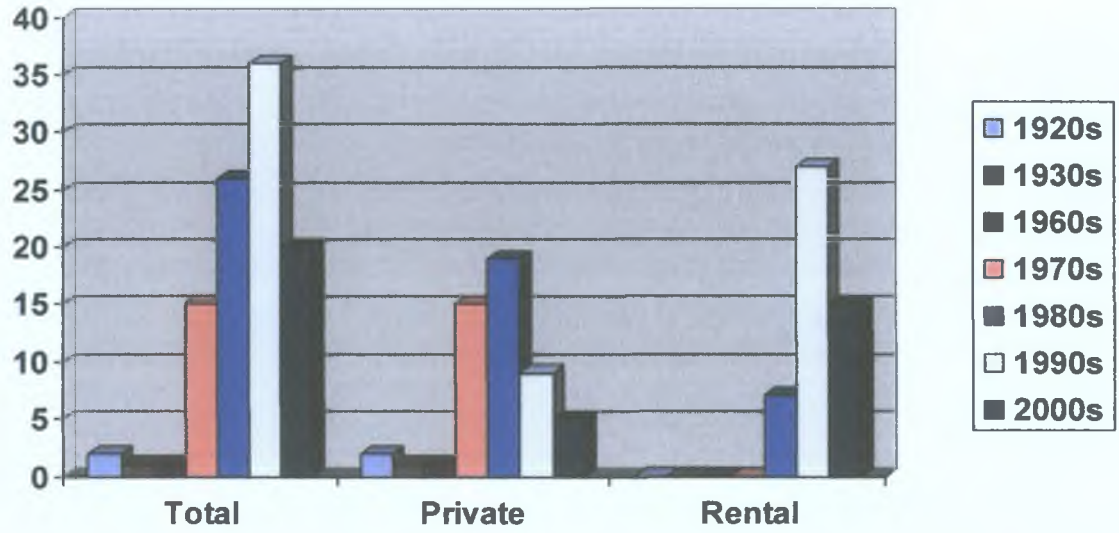

Figure 8 Decade of Manufacture of Vessel

Length of Vessel

The length of vessels on the river dictates the amount of public berthage that should be available and, of more relevance to this study, the space that should be available for boats at the Pump-out Station. Maximum lengths coincide with the converted barges of the canal era, which can be as long as 50 foot. In principle, this, plus space for manoeuvrability, totals the amount of space required at an on-shore sewage facility.

Boats are traditionally measured in feet; some of the newer vessels are constructed on a metric scale. Mooring is routinely calculated in multiples of three foot, such as 24ft, 33ft, etc.

The most popular vessels are between 30 and 36 foot in length. This trend is common to both private and rental boats.

Table 5.7 Length of vessels in feet:

Length in Feet	%	No. Private (total 49x)	No. Rental (total 51x)
24/25 ft	7%	4	3
27 ft	6%	4	2
29/30 ft	27%	12	15
32/33 ft	16%	9	7
35/36/37 ft	30%	11	19
39/40 ft	10%	5	5
42 ft	3%	3	-
45 ft	1%	1	-

On- Board Toilet Installation

Some boats had two toilet installations; this information was of no significance to the investigation. The type of installation and the number of persons on board represent the required data.

The particulars show that 2 out of 3 of the private boats have a sea toilet.

94% of rental boats have retrofitted holding tanks.

Table 5.8 On-Board Toilet Installation of boats surveyed

	Sea Toilet (discharge to river)	Holding Tank	Chemical Toilet
Private Vessels (49 total)	31	16	2
Rental Vessels (51 total)	3	48	none

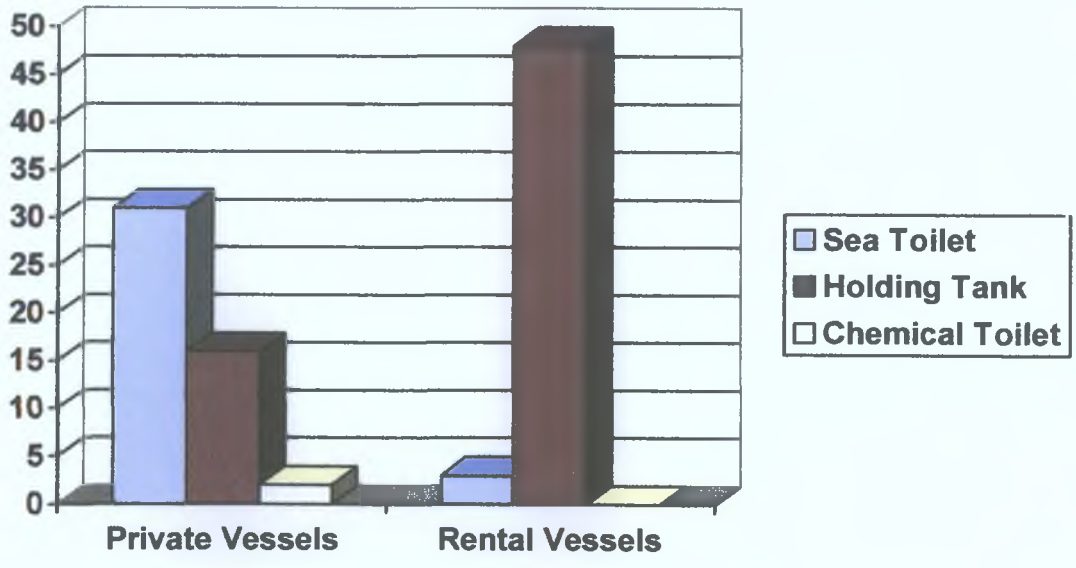

Figure 9 On-Board Toilet installation of boats surveyed

Number of berths and Number of persons punctually on board

The statistics revealed that an average of 3.3 persons boarded private boats, 66% of their full berth capacity. 83% of full berth capacity embarked on the cruisers within the rental sector, on average 4.5 persons per boat.

Table 5.9 Full Berth Capacity and Actual Person Days, per 100 boats surveyed.

	Full berth capacity	**Actual person-days**	**% occupancy**	**Average Persons per boat**	**% Sea Toilet**	**% Holding Tank**
Private (49)	243	162	66%	3.3	63%	33%
Rental (51)	275	229	83%	4.5	6%	94%

This data allows the calculation of possible person-days created per 100 boats and actual person-days created punctually. Those with a holding tank can choose to discharge sewage to the river or contain it. Both possibilities have been examined.

If the boats were to hold their full berth capacity, the polluting capacity would obviously be increased proportionately.

Table 5.10 Actual Person days related to toilet installation of 100 cruisers surveyed

	Actual Person Days x Sea Toilet to River	**Actual Person Days x Holding Tank Discharge to River**	**Actual Total Person Days Pollution to River**
Private (49)	102	54	156
Rental (51)	14	216	230

Table 5.11 Full berth capacity person-days related to toilet installation

	Full Berth Capacity Person Days x Sea Toilet to River	**Full Berth Capacity Person Days x Holding Tank Discharge to River**	**Full Berth Capacity Total Person Days Pollution to River**
Private (49)	153	80	233
Rental (51)	17	286	303

Length of Voyage and Duration of Cruise

The length of voyage and duration of the cruise in days are somewhat related. Factors that may create variations include overnight stays, stationary time spent or deviations from the direct route. The survey was carried out on the May Bank Holiday weekend. It was to be expected that many boaters would be making a three day trip.

One private cruiser had planned a two month trip, an exception to the norm.

The data revealed average trips of private and rental boats to be quite different in character. The rental skippers had chartered longer distances while the private owners made local trips.

Table 5.12 Most Common Itinerary

	Most Common Itinerary	**Average Number of persons on board**	**Average Number of days of trip**
Private	Lanesboro to Dromod and return	3.3	2
Rental	Carrick-on-Shannon to Athlone and return	4.5	5

5.6 Correlation of data relating to Pollution Load

The analysis of previously calculated data permits the computation of pollution load using the Load Factors for p.e. BOD $_5$ and Phosphate P.

Population equivalent BOD $_5$ = 60 g of oxygen

Phosphate per person per day = 2.7g

- 70% PO4 detergents = 0.8g estimated P to river

Table 5.13 Correlation of Person Days to Pollution Load, Private Boats

Private Boats x 49	Pollution from non compliant vessels as BOD_5	Pollution from non compliant vessels as P	Pollution total discharge of sewage to water as BOD_5	Pollution total discharge of sewage to water as P
Actual	102 x 60g = **6,120g**	102 x 0.8g = **81.6g**	156 x 60g = **9,360g**	156 x 0.8g = **124.8g**
Full Berth Capacity	153 x 60g = **9,180g**	153 x 0.8g = **122.4g**	233 x 60g = **13,980g**	233 x 0.8g = **186.4g**

The data relates to 49 private boats of 100 boats punctually surveyed. Non- compliant vessels are those with a Sea Toilet installation discharging directly to river. Total discharge of sewage to river proceeds from Sea Toilet installations and Holding Tanks discharging to river.

Table 5.14 Correlation of Person Days to Pollution Load, Rental Boats

Rental Boats x 51	**Pollution from non compliant vessels as BOD_5**	**Pollution from non compliant vessels as P**	**Pollution total discharge of sewage to water as BOD_5**	**Pollution total discharge of sewage to water as P**
Actual	14 x 60g = **840g**	14 x 0.8g = **11.2g**	230 x 60g = **13,800g**	230 x 0.8g = **184g**
Full Berth Capacity	17 x 60g = **1,020g**	17 x 0.8g = **13.6g**	303 x 60g = **18,180g**	303 x 0.8g = **242.4g**

The data relates to 51 rental boats of 100 boats punctually surveyed. Non- compliant vessels are those with a Sea Toilet installation discharging directly to river. Total discharge of sewage to river proceeds from Sea Toilet installations and Holding Tanks discharging to river.

The data reveals the importance of compliance across sectors.

Computation of BOD_5 and P per boat, per person day, per sector

A nominal pollution load per boat can be calculated from the data complied. The figures assume present boat conversion statistics, as per survey.

Table 5.15 BOD_5 and P values per boat, per person day, per sector

PRIVATE BOATS **Average Full Berth Capacity = 5 persons**		**BOD 5** **(g O_2)**	**P(g)**
Data presumes that ~ 66% of private boats are not converted.	Sea Toilet installation only, polluting to river	189.4	2.4
Possible pollution load if boats do not utilise retrofitted holding tanks	Holding tank retrofitted to sea toilet installation, Y valve open, polluting to river	289.4	3.8
RENTAL BOATS **Average Full Berth Capacity = 5.5 persons**		**BOD 5** **(g O_2)**	**P(g)**
Data presumes that 6% of rental boats are not converted	Sea Toilet installation only, polluting to river	19.9	0.27
Possible pollution load if boats do not utilise retrofitted holding tanks	Holding tank retrofitted to sea toilet installation, Y valve open, polluting to river	326.0	4.3

6.0 Consultation with Stakeholders

Local Authority Environmental and Planning Practitioners were contacted by telephone and by post (Appendix II) and by email. Three practitioners encouraged visits. The resultant data did not warrant statistical analysis, as in all sectors, data was too sparse to give precise figures.

6.1 Planning Authority Response

18 Planning Authorities corresponding to the County Councils that have jurisdiction within the catchment area were approached. Seven of the nine Planning Authorities adjacent to the navigable freshwater Shannon responded to the enquiry.

The following data was confirmed:

- Practitioners affirm that they are land planners and that planning applications for marinas are passed to the environmental department for assessment.
- Of the respondent planning departments, less than half confirmed that they referred to the Water Pollution legislation.
- Two planners thought that the Waste Management Act of 1996 had any relevance, though a waste management plan may be required as a planning condition.
- All of the practitioners affirmed the section 28 (1) (g) of the Planning and Development Act of 2000 had not been applied to date, though more than half of them had conferred with other authorities or interested parties as part of the planning procedure.
- The planning of marinas is universally treated on a "one to one" basis.
- All of the practitioners queried agreed that a Code of Practice would be helpful.

6.2 Environmental Department Response

Of the eighteen local authorities approached, only nine are bordering the inland waterway. The other authorities are situated on tributaries or the estuarine region. All of the Departments adjacent to the river were open to enquiry. The following data was determined:

- Four departments judged that current legislation is insufficient. The remaining five departments were satisfied that all requirements were met.
- None of the departments approached carried out specific water quality sampling at marinas, there is no specific requirement in law to do so.
- Eight of the nine departments affirmed that their Regional Management Plan required management of pollution at marinas.
- Six of them had taken steps to prevent pollution from marinas, though seven of them had rental companies within their jurisdictions.
- Four of them have demanded the installation of pump-out stations at established rental company bases and marinas.
- Five of the nine confirmed that new marinas are required to install a pump-out facility.
- All of the Environmental Departments neighbouring the Shannon abstract surface water for drinking water purposes.

7.0 Discussion

It is 14 years since the inception of The Shannon Navigation (Construction of Vessels) (Amendment) Bye-Laws of 1994, the prescriptive legislation to prevent the discharge of sewage from cabin cruisers to water. Previous and posterior legislation uphold water quality. The study clearly demonstrates that compliance requirements are not being met by any of the interested parties. Evasion is common among stakeholders, with each party clearly defending its own terrain, defining where one's legal brief stops.

There is a disparity of interests between land use issues and waterway matters, procedural difficulties and historical bargains. The development of simple projects is hindered because of an egalitarian hierarchical structure. Some concerns cannot be approached because there is no protocol written on the matter.

Avoidance should be examined to relieve the present gridlock regarding progression. Revealing the underlying causes is laborious. To the outsider, the solution would seem simple; enforce the existing legislation, though it may prove costly. Bureaucracy would seem to overwhelm all involved; particularly in the area of definition of remit. Meanwhile, the gaps conceal the unscrupulous and the ignorant alike. Compliance should be given prime importance, with all efforts serving this cause.

Infrastructure is insufficient; there is a definite misfit between the increasing need of boaters and the poor provision and maintenance of on-shore facilities. The existing functional pump-out facilities are inconsistently used, due to a lack of guarantee. A primary effort should be made to administer and maintain the existing installations under the direction of Waterways Ireland.

Because the population equivalent load from the pump-out to the wastewater plant cannot be calculated at present, the establishment of a coherent cost to the user is not feasible. The current cost of using the facilities should be wavered in order to encourage compliance. Harbours lacking toilet facilities should be refurbished to provide an alternative to use of on-board installations. Signage regarding next available facilities would aid logistical decisions.

Further infrastructural development should involve the construction of a pump-out station at one cruising hour intervals. Current cruising hours between facilities requires careful consideration, as a full tank may cause an unpleasant trip for all involved. Many vintage boats can only retrofit a 20 or 40 litre tank due to lack of available space. This means that cruising and stationary time (overnights, fishing, eating, etc.) must be regulated according to tank size. Private vessel data demonstrates that only 33% of crafts have a holding tank installed; some of these owners refuse to initiate the use of it due to present arrangements. This situation will not change if facilities are not improved and the changes recognised by the cruiser population.

Regarding both sectors of the cruiser population the facts relating to toilet retrofitting do not necessarily reflect practice; in particular the use of the "Y" valve causes concern. Generally, equipment specification permits the installation of a Y-valve which facilitates dumping to water or collection to holding tank. There has been no Code of Practice or guideline published to elaborate on the legislation. Thus enforcement of the legislation on the Shannon is difficult, as vessels are deemed to be compliant if a holding tank is installed, regardless of Y valve installation. A boat is not always required to hold sewage; in marine environments discharge of sewage to water is permitted. It can be

argued that in order to pass from freshwater to saline water, a boat needs to be considerably reconditioned, for example, the anti-fouling agent needs to be changed; reconditioning could include the manipulation of the Y valve. The counter claim exists, that in some cases, for Health and Safety reasons, the emptying of the tank may take priority over environmental issues. A Code of Practice should clarify these issues, and a means of reporting accidental spillage.

A cross-reference of the toilet installation results with the information given under question 4 of the questionnaire, aids recognition of trends. Of the private boat owners surveyed, eight admitted dumping to lakes; also seven persons reported having a holding tank but refusing to use it until further provision is made regarding pump-out facilities. Of the rental crews surveyed, almost 85% reported that they did not have any knowledge of how to empty the holding tank. This fact begs the question about continual discharge. When the full survey sheets of the vessels were examined, they revealed that some but not all new boats are fitted with holding tanks from the mid 1990s onwards. Surprisingly, a number of the Dutch imported steel boats manufactured in the late 1990s and early 2000s are not fitted with a holding tank. The additional data rendered under question 4 exposes the fact that many new boats fitted with a holding tank are discharging voluntarily to the lakes.

The education of river users should be given more precedence. Many boaters are aware of environmental issues, but it is obvious that not enough is known given the rates of discharge to water. A cultural change is required for those who are not aware of the real impacts of poor sewage management, and for first time visitors to the river. Greater

support for individual adherence to the Blue Flag criteria would encourage boaters to be self correcting and create a contagious sense of pride.

Legislation is layered, and coincides in generic prescription. It is written in "pockets" with each authority focusing on its own area of enforcement. The catchment area seems to be splintered into power cells, each dedicated to its own mission. The Shannon River Basin District Plan has brought stakeholders physically together, but has no authority in itself; it is a management system.

The fact that the EPA has no particular remit regarding the sector is perhaps the origin of much of the confusion. There is no strategy implemented as regards the various component authorities, enforcement issues, the monitoring of water quality at marinas and related. The failure of the EPA to create a Code of Practice is fundamental to the lack of clarity perceived. Though some of the stakeholders are working towards a sectoral code of practice, these protocols should reflect a central ethical theme.

Resources dedicated to the enforcement of legislation are inadequate. Both Shannon Navigation and The Shannon Regional Fisheries Board have two inspectors each to cover some 18,000 km^2. In both cases, the officers attend to arising court cases and associated duties. The powers of the inspectors are adequate but the implementation of an efficient inspection plan is obviously unachievable.

Inspection records for Shannon Navigation at best reflect an inspection rate of 0.005% of registered boats per annum. While resources are impoverished, the private and rental boat owner populations clearly perceive of a lack of enforcement.

To date the SRFB has not inspected any marina or rental company premises. The enforcement of sections 171 and 172 of the Fisheries (Consolidation) Act of 1959 would assure sectoral prevention of pollution to water.

Local Authorities do not monitor water quality at either marinas or rental company premises. It is obvious that the long-term storage facilities for cruisers have been left outside the sphere of activity of many of the pertinent authorities.

The Water Pollution Acts, Shannon Navigation Act and the Fisheries (Consolidation) Act all prescribe penalties. The fees are somewhat obsolete but could be upgraded to current monetary values. Both of these prescriptions are a source of finance for authorities that are struggling with resources. In many other inspectory sectors, fines are factored into budget forecasts and become an essential part of the sustenance of the service.

Section 27 of the Water Pollution Act of 1977 is redundant. This remedy could be used to create a mandate of co-operation, with powers to penalise all parties involved. The formation of one central authority would solve many of the problems related to the progressing stalemate. One central body could enforce several pieces of legislation, with the officers' role being comparable to the multifaceted task of Gardai at present. One authority would represent one mission and one mandate.

Redundant or abandoned legislation should be revisited by the authorities. The application of the recently transposed Strategic Environmental Assessment Directive requires a knowledgeable appreciation of impacts on sensitive receptors.

The extrapolation of the current water quality status into the future implies an increased threat of impoverished water standards. We run the risk of discovering that navigation

without change is a non sustainable. Within the boating and tourism sector consideration of the quantitative data, expressed in grams per boat reveals the true importance of working towards compliance. The registration data shows rapid annual increases in boat ownership, the problem is growing exponentially.

Efforts are required by all stakeholders to apply the established and emergent standards. With a proactive approach it is possible to create a tourist industry that will bring welcome finance into the region well into the 21st Century.

8.0: Conclusions

Current legislation is sufficient though the application of standards is lenient and enforcement is insufficient. The catchment area is managed by numerous authorities of equal status. Parallel forces are struggling with a lack of resources surrounding enforcement.

There is a lack of clarity regarding exactly what compliance to The Shannon Navigation (Construction of Vessels) (Amendment) Bye-Laws of 1994 means; the installation itself would seem to take precedence over the empirical requirement of not polluting waters. As a result, practice within the sector reflects apathy or evasion, or both.

There is evidence to show that generic legislation is redundant or selectively not applied to the sector, this neglect should be remedied. Communication between parties is often strained; there is some competitiveness and ambiguity of status. There is a duplication of tasks within parallel authorities.

The creation of an EPA Code of Practice for the sector would simplify current misconceptions. Expenditure on infrastructure is required in order to permit boaters to comply with the demands of legislation. The establishment of a single Shannon authority could alleviate many of the problems that are currently encountered, avoiding the splintering of resources and multiplicity of roles.

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APPENDIX I

Other Sources of Pollution

from Cabin Cruisers

which may have a Synergistic Effect

Ex Bilge:

Motor Oils and Grease:

Many of the cruisers use adapted tractor engines, incorporating a (river) water filter and adding a propeller to the end of the PTO shaft. Typically, a small cruiser would incorporate a 1500cc B.M.C./ Leyland or Perkins diesel engine, achieving some 35shp (6 knots per hour maximum speed), depending on the weight, draft and beam of the vessel. The PTO shaft must be regularly greased to enhance performance, but is lost because of frictional heat. As engine oil heats and thins out, it is purged through gaskets and valves. The accumulation of leaked engine oils and PTO grease in the bilge is proportional to length of the trip.

Condensate and Water Leaks:

The warmed air created as the motor heats comes into contact with the cold walls of the hull; this condensate creates sludge when mixed with other substances in the bilge. Other small leaks in the engine cooling system, the domestic water feed and the deck may add to this foul accumulation.

The use of an automatic bilge pump is recommended as a safety measure. Once the levels of slime reach the sensor, the pump activates and empties the bilge via a drain to the river. Automatic bilge draining pre-empts on-shore collection of bilge liquids

Exhaust fumes:

The exhaust outlet of most vessels is situated some 8-10 cm above the line of flotation. Consequently, pollutants such as particle matter, gases heavier than air and condensate fall to the water. Studies indicate that aromatic hydrocarbons such as methyl tert-butyl ether and BTEX compounds (benzene, toluene, ethylene and xylene) in waters significantly increase with leisure boat activity.

Noise:

Noise levels differ from vessel to vessel, with hydraulic engines creating the least amount of noise. The majority of crafts house a diesel engine in a fibreglass or steel hull, under wooden boards, creating an acoustic box. Depending on engine size and the frequency and precision of engine maintenance, more or less noise is created. Many of the newer high-powered craft create more or less noise depending on piloting style (revolutions per minute, torque values, wind speed, etc)

Noise from cabin cruisers is not generally perceived as nuisance, whereas comparable noise from lorries may cause complaint. However some evidence exists to suggest that wildlife may be affected by intrusive engine noise.

Voice noise may also be problematic in some mooring points, particularly where riverside entertainment coincides.

Ex hull:

Hull, Propeller and Anchor damage:

Damage to the river bed by the hull and particularly the propeller, either by direct impact at launching slopes or associated with running aground may be cumulatively significant. Occasionally, and generally for the purposes of fishing, a vessel may be anchored mid-lake. This results in physical damage to the fragile ecology of the river bed.

Wake:

Wake is the disturbance, or wave, caused to the surface of the water by the passage of the keel and propeller. Generally, the smaller vessels create very little wake, as they reach modest speeds. Many of the larger or powerful vessels are capable of creating considerable wake. The propeller has a whisking action on the surrounding body of water, splitting the water and creating foam. The movement caused by wake may also cause disturbances in neighbouring boats, for example, initiating the automatic bilge pump.

Behavioural factors which may affect the creation of wake include vessel ownership, status and experience. Behavioural aspects related to the hiring of cruisers are quite notable when compared to that of responsible boat owners. For many hirers, speed is part of the recreational package. As the stopping of a vessel depends on speed management, many collisions are caused by poor handling. Likewise, many of the newer, more powerful vessels which are demonstrative of money rather than a love of

the water are capable of "splitting the river". Inversely, the experienced captain uses the creation of foam as an indicator of speed. Prudent helmsmen will maintain foam at a minimum, thus increasing fuel efficiently, and maintaining standards of good navigational code of practice.

Anti-fouling Agents and related:

Freshwater vessels need to be treated every two to three years with an anti-fouling agent. This paint-like substance prevents the build-up of algal growth and some crustaceans on the surface of the hull. However, research has shown that these substances release toxins to the water over time. Tri-butyl-tin (TBT) was removed from anti-fouling agents in the early 1990s. Initial studies centred on the improvement of water quality regarding the release of TBT by-products to the surrounding water body. Further studies have centred on the release of alternative substances from the replacement finishes.

Alien Species:

When boats are imported or transferred from one body of water to another, macrophytes and invertebrate species may be transferred on the surface of the hull. Notoriously, the zebra mussel and the Canadian freshwater crayfish have infested Irish inland waterways. The removal of Value Added Tax on the importation of leisure vessels was one of the influencing factors on the increase of alien species on poorly cleansed hulls. Shannon Navigation Bye Laws prevent the transferral of vessels from

one body of water to another without hygiene measures. The level of compliance to these Regulations is highly questionable.

Refuse and Littering:

Domestic refuse collection

Domestic waste created typically in the galley kitchens of boats is generally provided for at public harbours and marinas. Local Authorities provide labelled (sometimes segregated) bins for the disposal of organic and non-organic waste. This system is limited by the inappropriate use of such bins by local residents and passers by.

Littering

Littering is common along the waterways and surrounding banks. The control of littering by wardens is generally not common. Much of the litter is non-biodegradable, for example, glass, plastics (for example, plastic furniture blown from vessels!) metal and wooden components. Much of it remains submerged in the water over time, creating safety hazards for other water users, such as bathers who may cut themselves, or boaters who may catch propellers in the offending matter.

Ex Sanitation:

Grey Waters:

Cruisers are normally fitted out with a galley style kitchen, complete with cooking and washing-up facilities. The drain from the sink generally leads directly through the two skins of the vessel to fall some 10 cm from the water line. The captain's handbook distributed by Waterways Ireland recommends the use of bio-degradable detergents. Generally washing-up water will carry food debris and detergents increasing nutrient loads in the receiving water.

Most cruisers will have a small hand-washing basin and shower in the toilet cubicle. Again, biodegradable products are recommended by Waterways Ireland. Perfume and cosmetic products are generally included in these compounds, many of which are synthetic and of difficult decomposition.

APPENDIX II

Communications with Local Authority Departments

Questionnaire Cruiser Population

Drumeel,
Ballinalee,
Co. Longford.
(043) 23975/
(087) 6834815
ergolex@eircom.net

6th May, 2008

Address

To the Senior Planner,

My name is Chris McCormack. I am a student at Sligo Institute of Technology, completing a dissertation for the award of M.Sc. in Environmental Protection. The title of the study is **"The Prevention of Sewage Pollution from Cabin Cruisers in the Shannon River Basin".**

. I understand, from my limited exploration to date, that specific legislation regarding marinas is scant. I would value any contribution of supplementary information that you could include. Should you wish to discuss any of the issues relating to the topic, please contact me by any of the above means.

I am specifically interested in ascertaining the number of private and commercial marinas regulated for the reception of sewage from vessels, and the control mechanisms currently in place.

I would be very grateful if you could complete the enclosed questionnaire as accurately as possible. All information furnished will be used solely for the purposes of completing the dissertation, and will be treated as confidential.

Please return the questionnaire in the S.A.E. provided, prior to 16th May 2008, as it will be processed shortly after this date.

I would like to thank you in advance for your co-operation, and recognise that without your participation, my research would be incomplete.

Receive my kindest regards,
Yours Sincerely,
Chris McCormack

Does your Planning Authority coincide with the navigable inland waterway?

Yes ☐ No ☐

If your answer is "No", please refer to Question 6 only.

Local Authority Baseline Data: Marina specific information only	
How many **Private Marinas** have sought Planning Permission since the inception of the Planning Act of 1963?	
How many **Cruiser Rental Marinas** have sought Planning Permission since the inception of the Planning Act of 1963?	
How many Encroachment Licences have been required since the PDA of 2000?	
To your knowledge, how many marinas have a pump-out station?	

Please note "marina" includes ***private and cruiser rental activity.***

Questionnaire: Planning Process for the Construction of a Marina

1. **When the Planning Department receives a Planning Application for a Marina, which are the items of legislation referred to?**

   The Planning & Development Acts ☐

   The Water Pollution Acts ☐

   The Waste Management Acts ☐

   Other, please state .....

2. **Does the Planning Authority..**

   Follow a Code of Practice/ Standard? ☐

   If yes, please give details .....

   Treat each application on an "individual case" basis? ☐

   Other, please state .....

3. **If the marina is part of a residential complex, which part of the planning application is given precedence?**

The Marina ☐

The Residential Complex ☐

Comments .....

4. **Does the Planning Authority require any of the following as a planning condition?**

That the marina be constructed within an area served by the municipal sewerage ☐

That the marina owner construct a Pump-out Station to sewerage ☐

That the marina owner construct a septic tank if not served by municipal sewerage ☐

That the marina owner construct a Pump-out Station to septic tank ☐

(If a septic tank is permitted, is a Waste Management Plan required? ☐)

That the marina be limited to (less than) a number of moorings ☐
if so, how many? (orientative).....

Other, please state .....

5. **Does the Planning Authority work in conjunction with any other body/ authority/ agency when dealing with Planning Applications for marinas?**

Waterways Ireland ☐

An Taisce ☐

The Environmental Protection Agency ☐

The Fisheries Board ☐

The Heritage Council ☐

Other, please state .....

6. Is there other information that you believe to be of importance to my research?

.....

.....

.....

If you would like to be included in the "acknowledgments" of the dissertation, please include your details, including your professional title:

Thank you for your assistance.

Drumeel,
Ballinalee,
Co. Longford.
(043) 23975/
(087) 6834815
ergolex@eircom.net

6th May, 2008

Address

To the Senior Environmental Officer,

My name is Chris McCormack. I am a student at Sligo Institute of Technology, completing a dissertation for the award of M.Sc. in Environmental Protection. The title of the study is **"The Prevention of Sewage Pollution from Cabin Cruisers in the Shannon River Basin".**

. I understand, from my limited exploration to date, that specific legislation regarding marinas is scant. I would value any contribution of supplementary information that you could include. Should you wish to discuss any of the issues relating to the topic, please contact me by any of the above means.

I am specifically interested in ascertaining the number of public moorings and private/ commercial marinas prepared for the reception of sewage from vessels, and the control mechanisms currently in place.

I would be very grateful if you could complete the enclosed questionnaire as accurately as possible. If the answer to a question is unknown, please indicate. All information furnished will be used solely for the purposes of completing the dissertation, and will be treated as confidential.

Please return the questionnaire in the S.A.E. provided, prior to 16th May 2008, as it will be processed shortly after this date.

I would like to thank you in advance for your co-operation, and recognise that without your participation, my research would be incomplete.

Receive my kindest regards,
Yours Sincerely,

Chris McCormack

Is your Local Authority adjacent to the Shannon? **yes□** **no □**

Local Authority Baseline Data: cruiser mooring related data only		
	Name & Location	~ Length in metres
Public harbour/ wharf/ quay, etc.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.	
Private Marina	1. 2. 3. 4. 5.	
Cruiser Rental Company Marina	1. 2. 3. 4. 5.	

Questionnaire: Sewage Pollution at Marinas (Private and Cruiser Rental)

1. Regarding Environmental Management at Marinas, does the Environmental Department consider:

   That current legislation is sufficient ☐

   That current legislation is not sufficient ☐

2. Regarding Environmental Management at Marinas, does the Environmental Department

   Follow a Code of Practice/ Standard? ☐

   Treat each marina on an "individual case" basis? ☐

   Comments .....

3. Does the Local Authority specifically monitor Water Quality at Marinas?

   Yes ☐ No ☐

   Comments .....

4. Do Marinas require any permit/ licence from the Local Authority?

Yes ☐ No ☐

If "yes", under what legislation? .....

Comments .....

5. Are there abstraction point(s) along the Shannon within the L. A. jurisdiction?

Yes ☐ No ☐

If "yes", please give details:

LOCATION	~ POPULATION SERVED

6. Has the Local Authority taken steps to reduce/ prevent pollution at Marinas?

Yes ☐ No ☐

If yes, please give details: .....

7. Does the Local Authority require that a marina has:

Pump-out Station ☐ A septic tank ☐ Limited moorings ☐

Other, please state .....

8. Does the Water Quality Management Plan include the control of pollution from

Cabin Cruisers ☐ Marinas ☐

Other related issue, please state .....

9. Is there other information that you believe to be of importance to my research?

.....

.....

.....

If you would like to be included in the "acknowledgments" of my dissertation, please include your details, including your professional title:

Thank you for your assistance

Sligo Institute of Technology

My name is Chris McCormack. I am completing a M. Sc. at Sligo Institute of Technology. The title of my dissertation is "The Prevention of Sewage Pollution from Cabin Cruisers in the Shannon River Basin".

I would be very grateful if you could complete the survey as accurately as possible.

All information furnished will be used solely for the purposes of completing the dissertation, and will be treated as confidential. *I would like to thank you in advance for your co-operation, and recognise that without your participation, my research would be incomplete.*

Chris McCormack, May 2008

Questionnaire: Provision of sewage services along the River Shannon:

1. Does your boat require the use of Pump-out Stations along the Shannon?

   Yes ☐ No ☐

2. Do you think that pollution prevention on the Shannon is important?

   Yes ☐ No ☐

   Comments .....
   (If Your answer is "No" to both of these questions, Please turn over, thank you)

3. What are the problems encountered/ envisaged? (tick as appropriate)

   Insufficient Pump-out Stations ☐

   Pump-out Station out of order ☐

   Pump-out Station in unhygienic conditions ☐

   Mooring close to Pump-out Station not available ☐

   Smart-card difficulties ☐ System difficult to use ☐

   Other/s .....

4. Is there other information that you believe to be of importance to my research?

   .....

Vessel and Voyage Survey:

Private vessel ☐ Hired vessel ☐

Approximate year of manufacture ..... Length in feet .....

No. of berths: ..... No. of persons on board today .....

Length of voyage: From : ..... To: .....

How long do you plan to cruise for? ..... days

Toilet installation: Sea toilet ☐ Holding tank ☐ Chemical ☐

-End of Survey-

Thank You for your participation.

Enjoy your trip!