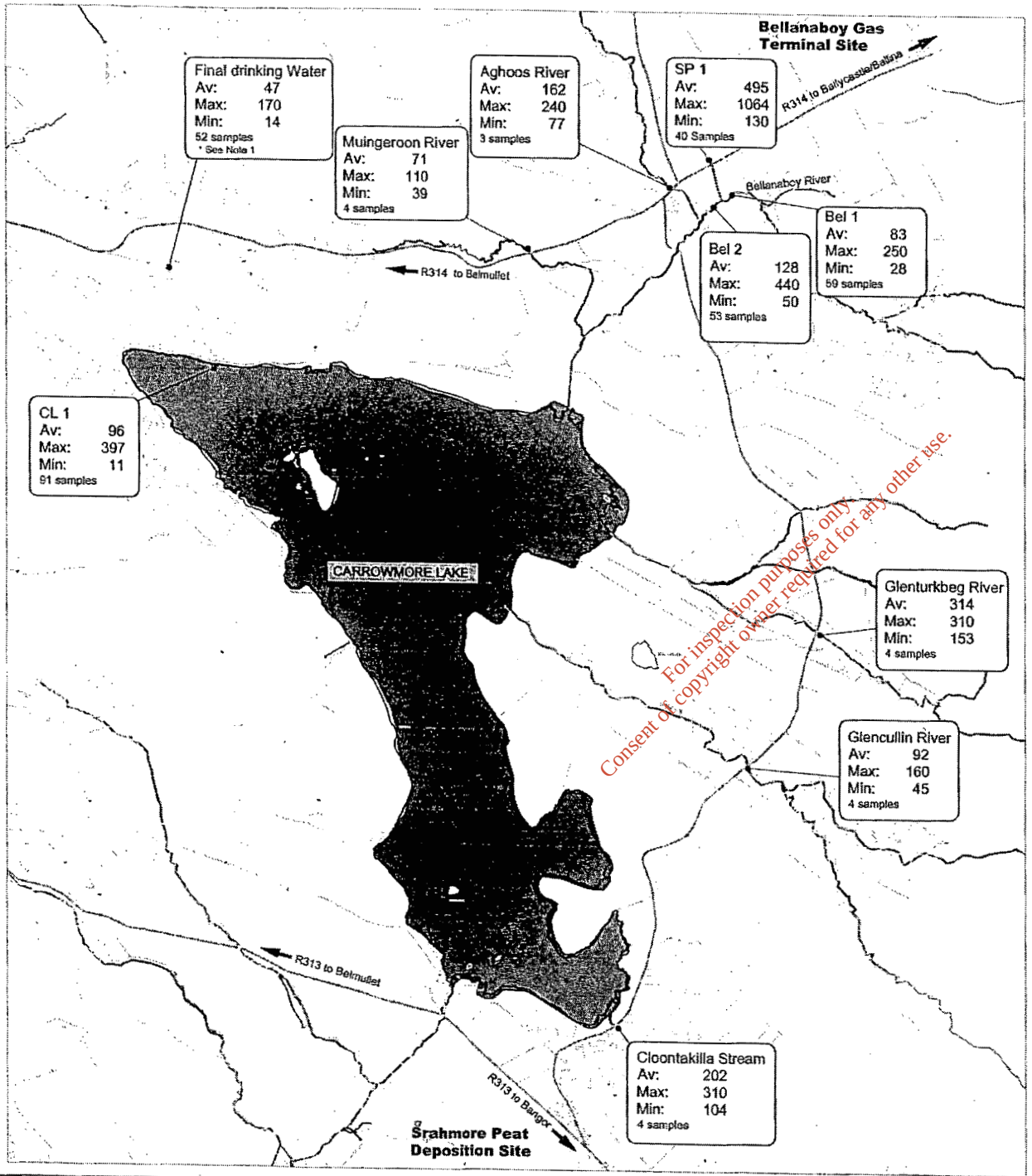

* Note 1
Does not include the following results for feb 1st 2006. The results are:
Total aluminium 70mgl
Disolved aluminium 251mgl

OH Doc No. 3 X

Recd From: Shell

Date Recd: 19/04/07

NO.	REVISION	DATE

MAYO COUNTY COUNCIL
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Project Title

Total Aluminium Results in Microgrammes/Litre & Locations

Scale NTS	Surveyed O.S.
Date March 2006	Designed R.C.
Drawn B.R. / R.C.	Checked P.M.

DRAWING No.

The North Western Regional Fisheries Board

RE: Aluminium toxicity in the Carrowmore Lake Fishery from the Bellanaboy catchment area.

Summary
Recent reports of toxicity and poisoning of Carrowmore Lake and its tributaries, due to aluminium discharges from the Shell Gas Terminal excavation, are completely unfounded from the fisheries perspective.

Background
As occurs with most metals, aluminium in its soluble form can be toxic to aquatic fauna and especially fish. Aluminium toxicity has been implicated in the decline of fish populations in regions where suitable environmental conditions exist for the formation of soluble aluminium salts. These conditions exist in catchment watercourses with very acidic or very alkaline pH ranges, and therefore, the catchment geology and rainfall chemistry has as much an influence on the biotoxicity as the metal has itself. The chemistry of aluminium is complex, but it is generally accepted that it is a component of the dissolved fraction of the element that will give an indication of its toxic ability. Low alkalinity and low pH in combination with high dissolved aluminium concentrations can lead to deterioration in the aquatic habitat and decline in fish stocks. Consideration of possible toxicity from elevated aluminium concentrations in its own right, without reference to alkalinity or pH of the receiving watercourse, is unrealistic.

Aluminium is an abundant element and forms a major constituent of catchment soils. Increases in aluminium in the Bellanaboy River from the Shell terminal site would be expected due to discharges of the non settling mica or mineral soil from the site. However, aluminium concentrations recorded in the river would also consist of soil material washed off from the catchment area, but importantly, from eroding river banks during flood events. The question of toxicity due to increased levels of dissolved aluminium from discharges from the terminal site was an issue raised with the developer over a year ago. Subsequent meetings with Mayo County Council resulted in the implementation of a water quality monitoring programme aimed at detecting any effect due to increases in aluminium.

Water Quality in the Lake and its tributaries
Mayo Co. Co. have regularly updated the Fisheries Board on the results of the water quality monitoring programme. Comprehensive sampling by the local authority has resulted in a significant collation of results relating to the background physio-chemistry of this lake and its catchment tributaries.

Weekly analysis of the Muingingaun River (tributary of Bellanaboy) from the 2 November 2005 at BEL 1 (upstream) and BEL 2 (downstream) has revealed an increase of 36.5% in dissolved aluminium concentrations downstream of the control point, due to the discharge from the terminal site. This increase is insignificant in terms of the overall load to Carrowmore Lake from all of the catchment tributaries. The average dissolved aluminium level in the adjacent catchment at Glenturk Beg (a

control site) is 2.3 times higher than below the discharge at BEL 2. In fact, the discharge of dissolved aluminium at SP1, draining the terminal site itself, has been found to be lower in concentration, on occasion, than the adjacent Glenturk Beg.

Total hardness, conductivity and pH concentrations measured during this time would also suggest that the conditions required for aluminium toxicity, do not pertain, in the Bellanaboy catchment. Long term water quality datasets, including those undertaken at EIS stage for this proposed development, reveal a medium buffered catchment thus preventing against any significant pH drop that could cause episodic acid events resulting in any decline in habitat value.

Sampling Location	Description	Sample No.	Total Aluminium (ug/l)	Dissolved Aluminium (ug/l)
SP1	Discharge Location	50	428.5	131.5
Bellanaboy 1	Upstream of Discharge	60	79.3	47.7
Bellanaboy 2	Downstream of Discharge	60	125.1	65.1
Cloontakilla	Control Site	4	202	113.5
Glencullin	Control Site	4	92	40
Glenturk Beg	Control Site	4	217	152
Aghoos	Control Site	4	162.3	99
Muingeroon	Control Site	4	71.3	49.3
Carrowmore Lake	At intake	94	96.8	42.8

Table 1. Aluminium concentrations Carrowmore Lake 05 – 06
(modified from Mayo Co. Co.)

A scheme called the SSRS (Small Stream Risk Score) developed by the EPA and the Western River Basin District, as part of the implementation of the Water Framework Directive, was also applied by the Fisheries Board at BEL 1 and BEL 2 during March 2006. Both sites scored well with a dominance of the ephemeroptera (mayflies) including *Baetis spp. Rithrogenia spp. Heptagenia spp.*, and *Ephemera danica,* which is typically found in hard waters.

The general presence of a number of ephemeropteran species and the abundance of *Baetis* suggests that acidity is not a problem in these streams as the year-long life cycles would result in their elimination even if there were episodic occasional acidity events. *Baetis* is a widely used indicator of acidity in the sense that while it is tolerant of reasonable degree of organic pollution or eutrophication it is sensitive to acidity and has a high indicator value in various acidity indexes that are used around Europe. The fact that the system is not particularly acidic would also suggest that aluminium toxicity is unlikely. Bearing in mind that subsoils are likely to contain quite a high percentage of aluminium it is not surprising that high total aluminium concentrations are recorded. (Dr. Martin McGarrigle *pers. comm.*).

Dissolved aluminium toxicity is linked with very low pH waters which is obviously not the case here. Similarly in Carrowmore Lake, pH values and total hardness will mitigate against any toxicity to the aquatic fauna due to aluminium. It is worth mentioning that the buffering capacity or high calcium concentrations measured in the Bellanaboy River and at SP1 is probably due to the "over burden" or mineral soil element overlying the catchment i.e. the source of the aluminium in the first instance.

It must also be made clear that the discharge from the Shell terminal site is not the most significant loading of dissolved aluminium to the lake; which occurs in the Glenturk Beg due to the lower buffering capacity experienced in this catchment. Any elevated aluminium levels experienced in Carrowmore Lake are rather more likely to be due to the shallow nature of this lake (mean depth 1.9 metres max. depth 3.5 metres) and the resuspension of sediment from the lake bottom.

Interpretation of the water quality dataset must be carried out with caution, and certainly so in the case of aluminium, due to its complex chemistry. The reliance on water quality standards, albeit with their legal consequences, must take account of local effects due to specific physical characteristics in individual regions including catchment geology and soil cover.

Carrowmore Lake Fishery

This lake and its catchment area represent one of the most intensively studied fisheries in the North Western Fisheries Region, and the fisheries Board is committed to long term studies of both the fish stocks and their habitat. The Fisheries Board has invested significant resources to the management of this fishery, including the installation of a fish counter, annual fish stock assessments, aquatic habitat surveys and developments of a Fisheries GIS. The lake has an excellent run of salmon and grilse (smaller summer salmon) and has the reputation as one of the finest spring salmon lake fisheries in the country. This reputation is backed up by a reliable fish count for this fishery, the statistics from which will allow for the monitoring of this vulnerable component of the national salmon run in the future. Carrowmore Lake also enjoys a good run of sea trout each summer.

Unfortunately, Carrowmore Lake has experienced a serious decline in water quality in recent years due to eutrophication. The major environmental threat to the future sustainability of this resource is due to this problem of enrichment. The Fisheries Board has recently published a report on a two-year study of this problem including recommendations aimed at restoring the lake to good quality. The main cause of the enrichment problem was found to be land use practices, mainly agriculture and forestry. This is by far the most significant environmental threat currently facing this lake.

The latest information available to the Board indicates that Carrowmore holds a healthy stock of spring salmon at present.

PMC Meeting 5 April 2006:
EPA Comment on Environmental Monitoring Results.

Scientists at the Environmental Protection Agency have studied the monitoring results for the Bellanaboy site, particularly in relation to aluminium. NWRFB Biological results in the stream upstream and downstream of the discharge point have also been examined.

The widespread nature of aluminium in soils means that any soil-water mix is likely to have high total aluminium levels. While aluminium becomes toxic in highly acidic waters, the extensive measurements of pH made in this case plus the presence of a range of mayfly insect nymphs in the stream upstream and downstream of the discharge point, suggest that acidity is not a problem here. Thus, aluminium toxicity is not seen as a major concern in Carrowmore Lake or this tributary.

The sensitivity of mayfly nymphs to acidity makes them particularly useful as indicators of acid 'events'. They are widely used in biological indexes to assess the impact of acid rain on rivers and lakes. Aquatic insects typically have a one-year life cycle before emerging as adult insects and thus, they can be regarded as 24x7 continuous monitors of water quality. Regular monitoring of macroinvertebrates (insects in particular) can provide an integrated assessment of a wide range of potential hazardous substances discharged into water and of the overall impact on the aquatic ecology. The invertebrates, and indeed fish, provide an early warning of potential hazards to human health.

The potential for suspended solids to silt up spawning habitat is regarded as a more serious environmental threat than aluminium at Bellanaboy. The Freshwater Fish Directive standard for suspended solids in salmonid waters is 50 mg/l (annual average value). It appears that the Axonics treatment plant can reduce the level of suspended solids sufficiently and reduce the concentrations of many other impurities; but it needs to be scaled up to cope with the volume of water likely to run off the site.

Carrowmore Lake has suffered from quite a severe eutrophication/excessive algal growth problem for some years, due to phosphorus inputs. The abundance of algae in the lake is greater than that predicted by the measured phosphorus inputs to the lake. It is believed that at least some of the excess is due to phosphorus being desorbed from the sediments into the lake water, stimulating algal growth. Such desorption of phosphorus is most likely to occur during windy conditions when the bottom sediments are re-suspended up into the lake water. Effectively the sediments may have become saturated with phosphorus with the result that phosphorus is more easily desorbed. In this context it is perhaps worth noting that aluminium binds phosphorus very strongly. As a result it is likely that the less aluminium in the lake sediments, the lower the ability of the lake to cope with phosphorus inputs. In North America the practice of treating whole lakes by adding large quantities of aluminium salts in order to bind phosphate in order to eliminate potentially toxic algal blooms is quite common.

The Carrowmore drinking water treatment plant uses aluminium salts to purify the water taken from the lake. Thus, the amount of aluminium in the intake water is to a certain extent irrelevant because the water treatment process actually requires the deliberate addition of aluminium salts and the manipulation of the pH in order to ensure removal of impurities. The operation of the water treatment plant is monitored routinely. The EPA reports on compliance with drinking water regulations in regular national reports on drinking water. The EPA views any breaches of drinking water standards very seriously. The EPA also notes the fact that Mayo County Council are undertaking daily measurements of aluminium in the treated water in order to inform local residents of the actual aluminium values in the finished water leaving the plant.