Ref: AWE/DSDG/B/RP/AD/2302

AWE Report 440/08

RSA93 Authorisation BZ1994 for AWE Aldermaston, Schedule 9, Improvement Requirement 5:

Minimisation of Radioactive Aqueous Discharges

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EXECUTIVE SUMMARY

Each year between 25,000 and 60,000 m^3 of treated trade effluent is discharged to the public sewer, and hence to the environment, from the AWE site at Aldermaston. The radioactivity in the discharges has to comply with the limits and other requirements of a discharge authorisation granted by the Environment Agency under the Radioactive Substances Act (RSA). In practice AWE's aqueous discharges contain so little radioactivity that it is not possible as a matter of routine to distinguish between the contribution from AWE's operations and the natural background activity that is always present – the two are reported together.

Regulatory radioactivity limits for AWE's discharges to the sewer are set in terms of becquerels per year. However, now that AWE's liquid discharges of radioactivity are little above the natural background observed through environmental monitoring of surface waters in the district, they should be compared instead to the World Health Organisation drinking water guidelines. With this in mind the Environment Agency included within Schedule 9 of the RSA authorisation the Requirement No. 5, as follows:

> *The Operator shall undertake a programme of work to identify the means to minimise the radioactive aqueous effluent discharged into the environment by use of the route to the Silchester Sewage Works with the end point of determining whether it will be possible to ensure that the activity of the discharge should be equal to, or less than, the World Health Organisation screening levels for Drinking Water.*

This report deals with:

- the use of water within, and effluent disposal from, the site;
- policy and regulatory drivers;
- descriptions of the two aqueous treatment plants and the effluents they discharge;
- the steps taken by AWE, in compliance with its obligation to apply 'the best practicable means', to minimise the activity and volume of aqueous wastes;
- a comparison between the World Health Organisation drinking water guidelines for radioactivity and the activity concentrations reported for Aldermaston's liquid discharges; and
- the data relating to discharges over a number of years, including data for non-radioactive effluent constituents.

This report is offered as AWE's response to the Environment Agency Requirement. It is further concluded that the aspiration expressed by Requirement 5 has already been realised.

It is recommended that AWE should enter dialogue with the Environment Agency with the objective of amending its RSA waste disposal authorisation to reflect better than at present the very low levels of radioactivity present in aqueous discharges from the Aldermaston site.

Prepared by:	C A Hunt Assurance Environment Department	Signature Date
Approval:	W G Beard Head of Environment	Signature Date

AMENDMENT RECORD

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1. INTRODUCTION

Each year between 25,000 and 60,000 m^3 of treated trade effluent is discharged to the public sewer from the AWE site at Aldermaston. The reasons for the variability are given later in this report (e.g. see section 4.2), but 35,000 m^3/year is used as a 'best estimate' for the next few years. The discharge has to comply with the limits and other requirements of both a trade effluent consent to discharge granted by Thames Water Utilities[1] under the Water Industry Act, and a discharge authorisation granted by the Environment Agency under the Radioactive Substances Act (RSA)[2].

The limits for radioactivity in aqueous waste allowed by the RSA discharge authorisation have progressively reduced over the years (see Annex 1). The reductions have been possible – volunteered by AWE – partly because of improvements to the on-site control of sources of radioactivity, and partly because better measurement techniques have been developed and put into use for very low concentrations of radioactivity in effluent. Modern techniques offer a lower limit of detection, so discharge results reported now are a more realistic assessment of the actual radioactivity in the discharges rather than simply a demonstration of compliance with the limits. Even so, it is still not possible as a matter of routine operation to distinguish between the low levels of natural background radioactivity which are always there (as evidenced by results from many years of environmental monitoring) and the very small amounts of radioactivity present in addition as a consequence of AWE's work practices. The 'discharges' reported are the sum of both these contributions and therefore still exaggerate the radioactivity discharged as a result of AWE's work practices.

So far the aqueous effluent radioactivity limits for discharges to the sewer granted by the Environment Agency have always been set as integrated totals, in units of becquerels (Bq) per year (where 1 Bq is one atomic disintegration per second). Now that AWE's liquid discharges of radioactivity have reduced to little above the natural background, it becomes more useful to compare the radioactivity concentration in each discharge to the World Health Organisation drinking water guidelines, and to check that the variation of concentrations between discharge batches is relatively slight. With this in mind the Environment Agency included within Schedule 9 of the new RSA authorisation issued in early 2007 Improvement and Additional Information Requirement No. 5, as follows:

> *The Operator shall undertake a programme of work to identify the means to minimise the radioactive aqueous effluent discharged into the environment by use of the route to the Silchester Sewage Works with the end point of determining whether it will be possible to ensure that the activity of the discharge should be equal to, or less than, the World Health Organisation screening levels for Drinking Water.*

This report summarises work done within AWE at Aldermaston to minimise discharges of radioactive aqueous effluent, both volume and activity. It also compares the residual levels of radioactivity in the environmental discharges (i.e. to sewer, where there is substantial further dilution) with the relevant World Health Organisation drinking water guidelines. The report is therefore offered to the Environment Agency as AWE's answer to the Improvement and Additional Information Requirement.

2. WATER USE AND EFFLUENT DISPOSAL – A SUMMARY

Until 2005 the annual consumption of potable water within the AWE Aldermaston site was more than 1,000,000 m^3. Most was put to good use but some was lost through leakage. Since then there has been a major, and successful, campaign to reduce leakage. Even so, in the year to March 2008 the site supply included 565,000 m^3 extracted from the on-site boreholes, with a further 115,000 m^3 of towns water supplied by Thames Water, i.e. nearly 700,000 m^3 in total.

The majority of this water is for normal domestic purposes (i.e. drinking water, lavatory flush systems, wash basins, kitchens, etc). Some is for conventional (i.e. non-radioactive) process use. A small fraction, less than 10% of the total, is used in circumstances that lead to a potential for radioactive contamination in the process effluent. This is an unavoidable consequence of fulfilling the site's core purpose of maintaining the UK's nuclear deterrent.

For the management of aqueous radioactive waste (effluent) within the AWE Aldermaston site, sources of effluent can be considered in two principal categories. These are described in the following paragraphs, with Figure 1 providing a diagrammatic summary. A third category could be defined – see section 2.3 below – but the discharges from this source have already been acknowledged by the Environment Agency as matching the local background observed over many years through the environmental monitoring programmes carried out by AWE and others.

2.1 The first category includes all processes and facilities that generate what is termed 'active effluent', i.e. aqueous waste that is definitely radioactive following its use in a process giving contact with radioactive material. Active effluent is transported in approved containers to the Radioactive Waste Treatment Plant (RWTP). The total volume is relatively small, about 1,000 m^3 per year but, until there has been treatment by the RWTP, the liquid contains much more radioactivity than the larger volume of effluent routed directly to the site Trade Effluent Treatment Plant (TETP). After treatment in the RWTP, the 'active effluent' – from which, in practice, nearly all radioactivity has been removed – is discharged to the TETP where it mixes with the much larger volume of effluent from other (potentially) radioactive sources. Note that there is no direct off-site discharge of treated effluent from the RWTP.

2.2 The second category is the larger and more diverse facility group: it contributes most of the total trade effluent volume, upwards of 25,000 m^3 per year (expected to be about 35,000 m^3 per year). The contributing facilities include all processes which by their nature are unlikely to add much radioactivity to the effluent, even if there remains a finite possibility of this happening. It also includes all facilities that may have handled radioactive materials in the past, just in case their discharges to the treatment system could transport any residue of the earlier operations. These effluents are supplied directly to the TETP, usually via installed pipes. Effluent received by the TETP include the (pre-)treated discharges from the RWTP. Any treatment necessary to enable the bulk effluent to meet the limits and conditions of the trade effluent consent and the RSA disposal authorisation is applied at the TETP before final discharge to the sewer.

2.3 In addition to these categories there is a small discharge of tritium authorised[2] via the North Ponds Water Management System (WMS). The WMS is a system of concrete tanks with a total capacity of 22,000 m^3. The complex provides a hold-and-monitor capability for surface water from that part of the Aldermaston site within which are positioned most of the radioactive materials processing facilities. The duty tank is filled before being monitored to demonstrate compliance with the Water Resources Act[3] and Radioactive Substances Act discharge consents and subsequent discharge to the local stream.

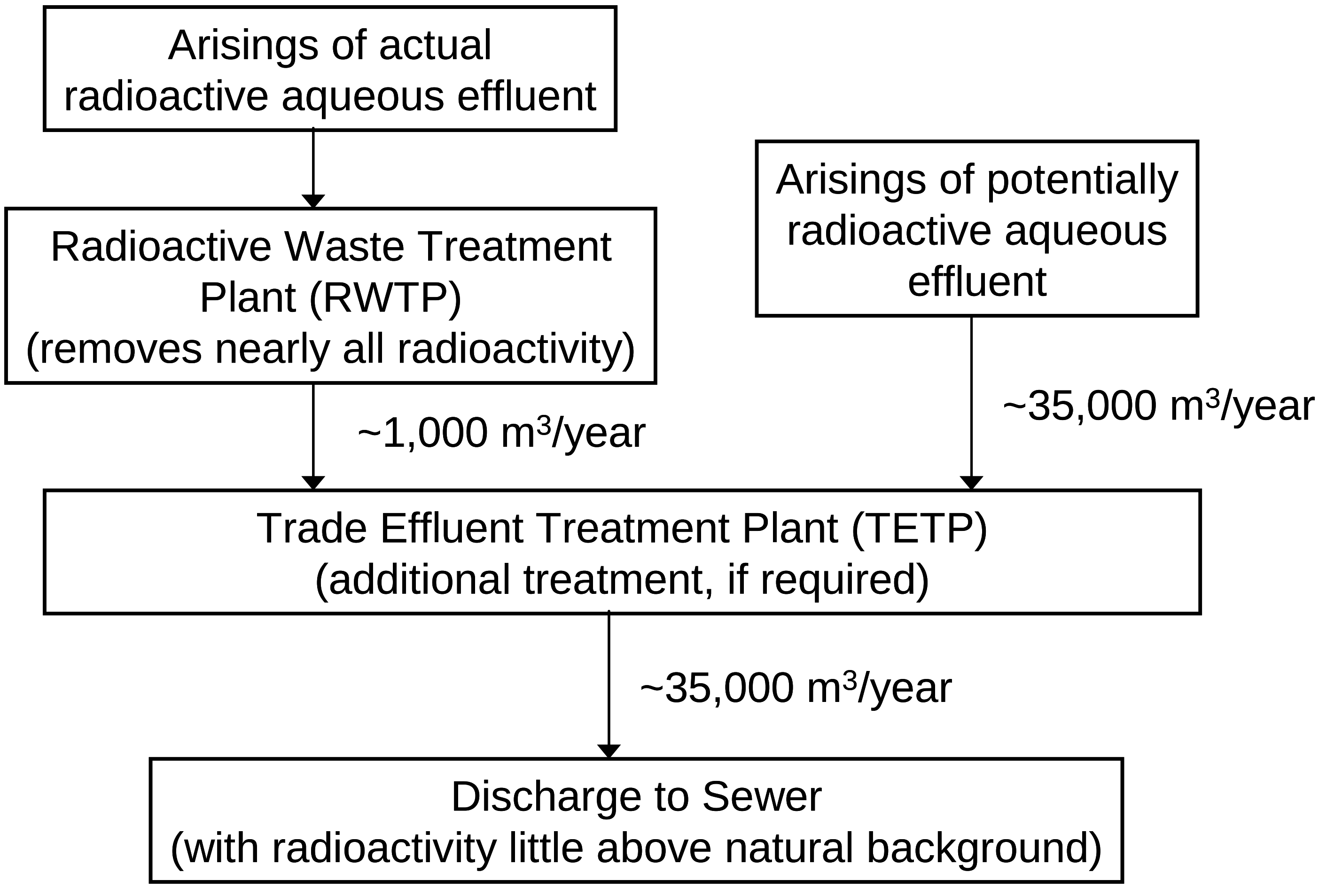
Groundwater lightly contaminated with tritium has to be continually pumped from around the outside of the concrete tanks. Failure to do this would result in damage to the structure as a whole, as full tanks weigh down while empty tanks would tend to float. The groundwater is managed by being pumped to mix with the surface water collected by the system. The volume and tritium concentration of the pumped groundwater is routinely reported to the Environment Agency.

The additional tritium in the groundwater adds very slightly to the concentration of tritium already present as background in the surface water. However, the Environment Agency accepted in 2004 that:

- AWE has done everything reasonably practicable to minimise this source of tritium discharge;
- the concentration of tritium in discharges to the stream from the North Ponds WMS, at about 0.1% of the World Health Organisation recommended guideline for tritium in drinking water, is in any case not distinguishable from local background.

Since this already comfortably meets the objective wanted by the Environment Agency (…*to ensure that the activity of the discharge should be equal to, or less than, the World Health Organisation screening levels for Drinking Water*), no further attention is devoted to this discharge stream within this document.

Figure 1: Radioactive Effluent Sources, Treatment and Disposal – a Summary



3. POLICY AND REGULATORY DRIVERS

3.1 For AWE the national expectation for sustainable development, such as the use of water as a resource, is expressed through the Ministry of Defence publication JSP418[4]. This expects MoD organisations, including sites such as AWE Aldermaston which are managed by contractors, to integrate sustainable development into policy making and to make all resource acquisition more sustainable. Volume 2 Leaflet 17 of JSP418 includes as objectives: '*Safeguard water resources and reduce consumption*', and '*Ensure that the consumption of energy and water is managed in an efficient manner consistent with maintaining the Department's military effectiveness. Particular importance is to be attached to economy in the use of energy and water in order to reduce greenhouse gas emissions, impact on natural water resources and running costs*.'

3.2 AWE's own Environment Policy[5] states that: '*AWE ensures its activities comply with and meet obligations relating to the protection of the environment, by ensuring compliance with all relevant customer, statutory, regulatory and internal requirements. AWE takes into account the environmental effects of its activities, measures and assesses the impact of its activities on the environment and makes arrangements to minimise any effect*.' This policy statement is supported by commitments to (*inter alia*):

- Introduce sustainable development into all our processes and activities;
- Reduce the consumption of resources (material, fuel and energy); and
- Minimise waste through a commitment to recovery and recycling where feasible.

3.3 AWE's Environment Policy is supported by other documents, including:

- AWE Corporate Sustainability Plan[6];
- AWE Energy Strategy[7]; and
- AWE Aldermaston – Utilities Strategic Plan[8].
- AWE Integrated Waste Strategy 2008[9].

Each of these contains objectives and commitments that, taken together, underline AWE's determination to minimise water use and disposal, whether radioactive or not, and to apply the principles of sustainable development wherever reasonably applicable.

3.4 The Environment Agency has chosen to reinforce the pressure for AWE to minimise its discharge of radioactive aqueous waste into the environment by introducing an 'Improvement and Additional Information Requirement' into Schedule 9 of the RSA discharge authorisation granted in 2007. It is that:

The Operator shall undertake a programme of work to identify the means to minimise the radioactive aqueous effluent discharged into the environment by use of the route to the Silchester Sewage Works with the end point of determining whether it will be possible to ensure that the activity of the discharge should be equal to, or less than, the World Health Organisation screening levels for Drinking Water.

This report summarises the work done and the conclusions reached and is therefore offered as AWE’s response to the Environment Agency Requirement quoted above.

4. DESCRIPTION OF TREATMENT PLANTS

As noted, radioactive aqueous waste generated by AWE at Aldermaston falls into one of two categories – smaller volume but more contaminated 'active effluent', or much larger volume but less contaminated 'trade effluent'. The first category is treated primarily at the Radioactive Waste Treatment Plant (RWTP) before being added to the bulk trade effluent stream for further treatment within, and discharge to sewer from, the Trade Effluent Treatment Plant (TETP). This section of the report provides summaries of the two treatment plants.

4.1 **Radioactive Waste Treatment Plant (RWTP)**: The design of this plant grew out of a Best Practicable Environmental Option study conducted in 2000. It was concluded that the then existing ferric flocculation plant, which made discharges of mildly radioactive treated effluent via a pipeline to the Thames, should be entirely replaced by a new plant, the RWTP, which uses evaporation and reverse osmosis filtration to remove virtually all particulate and dissolved radioactivity from effluent. One benefit of the construction and operation of this plant has been the complete halt in early 2005 to aqueous radioactive discharges to the Thames. The purified water produced by the RWTP is discharged as one input to the on-site Trade Waste System, while the separated residues containing nearly all the radioactivity are encapsulated in cement for disposal as solid waste to the national Low Level Waste Repository in Cumbria.

For the RWTP to be a reasonably practicable alternative, it was necessary to reduce substantially the annual volume of active effluent needing treatment. The previous ferric flocculation plant had treated some 7,000 m^3 of effluent each year, several times as much as would have been appropriate for an evaporator-based plant. Steps were therefore taken to decommission the old effluent collection system which had contributed very significantly to the overall volume by the infiltration of rainwater and groundwater which had to be treated as 'active effluent' once within the system. Further steps were taken to review all effluent sources and to ensure that only those justified by history or current operations continued to supply effluent to the RWTP. The outcome of this series of initiatives is the RWTP, designed to treat a maximum of 2,500 m^3 per year. It has been operational since 2005, but has in fact had to treat only about 1,000 m^3 of active effluent per year, all of which is conveyed to the plant in approved containers, rather than by installed pipes.

AWE operations require the use of plutonium, uranium and tritium, all of which are radioactive. Uranium and tritium both occur naturally, plutonium only as a result of nuclear fission. In addition, one isotope of plutonium (Pu-241) decays with a relatively short half-life to americium, so any contamination by plutonium will include some americium contamination in addition. Two points arise from this and should be noted:

- The combination of evaporation followed by reverse osmosis is, as noted, extremely effective for removal of all dissolved and particulate contamination. This includes uranium and plutonium (with americium), but does not include tritium. Tritium is an isotope of hydrogen and is chemically identical to hydrogen. Therefore neither evaporation nor reverse osmosis filtration will reduce or remove tritium from water, nor is there any reasonably practicable alternative to achieve this. The consequence is that any tritium in the active effluent supplied by facilities will pass straight through the RWTP, and the same is true for the TETP. On the other hand, note that the site discharge limit for tritium in aqueous waste is very small, and AWE is careful to design facilities and processes to keep tritium out of aqueous waste streams as far as possible.

- In facilities in which plutonium (and americium) are processed, all effluent classed as 'active' (i.e. it is definitely contaminated) is routed for treatment and disposal via the RWTP. This ensures that no plutonium (or americium) above background reaches the TETP. As a result there is in effect a 'nil discharge' of plutonium (and americium) by AWE in liquid discharges to the sewer.

4.2 **Trade Effluent Treatment Plant (TETP)**: This plant collects trade effluent from operations and facilities across the Aldermaston site, much of it via an installed 'trade waste' system of collection drains. Some (but not all) of the donors process uranium, or have done so in the past, and effluent contributions from these either do or may contain low levels of uranium activity. The annual volume for treatment and disposal used to be in excess of 100,000 m^3 but, following campaigns of re-lining the drains and manholes, has been nearer to 35,000 m^3 in recent years. This latter total did increase temporarily – by a factor of about two – when for operational reasons the discharges from the site powerhouse water purification plant had for a time to be directed to trade waste, rather than to the foul drain.

Discharges from the TETP have to meet the limits and conditions of two separate regulatory permissions – the Water Industry Act trade effluent consent granted by Thames Water Utilities, and the Radioactive Substances Act discharge authorisation granted by the Environment Agency. Compliance is checked by examination of spot samples taken before each batch discharge commences, and is confirmed by detailed analysis of samples collected by a proportional sampler operated while the discharge is made. It is the results from the detailed analysis that are used for compliance reporting. The history of compliance is shown by the data in tables and graphs in Annexes 1 to 3. Note that the compliance requirements do not apply directly to the effluent supplied to the TETP by the RWTP, although AWE does of course have a close interest in checking that the water quality parameters of the RWTP product will not adversely affect the capacity of the TETP to comply with its regulatory permissions.

The treatment of effluent by the TETP prior to discharge includes pH adjustment (if needed) and clarification and is commensurate with the quality of the waste received from facilities and the RWTP. After confirmation that the effluent meets all external and internal quality requirements, discharge of the liquor is made to the local sewer. Sediment accumulates slowly in the clarifier and is, from time to time, collected and analysed. Disposals of the sediment are made in compliance with the requirements of the Radioactive Substances (Phosphatic Substances, Rare Earths, etc) Exemption Order 1962.

5. DESCRIPTION OF AQUEOUS EFFLUENT

5.1 As apparent from the information in Section 4, the effluent discharged to sewer is a mixture of the treated product from the RWTP (about 1,000 m^3 per year) and other sources on site (about 35,000 m^3 per year).

5.2 The treated RWTP product contains very little dissolved or particulate radioactivity, although there is no removal of tritium (see Section 4.1 for explanation). Annex 3 records the discharge data for the plant.

5.3 Discharge of purified effluent from the RWTP is to the site Trade Waste system. The site Radioactive Substances Act discharge authorisation, like the trade effluent consent, applies at the point of discharge from the site, not at the point of discharge from the RWTP into the Trade Waste system. There are therefore no regulatory limits governing the discharges made from the RWTP to the on-site Trade Waste system although AWE does, of course, monitor levels to ensure the discharges do not threaten AWE's compliance with the authorisation and consent governing the Trade Waste discharges from site.

5.4 The Trade Effluent Treatment Plant collects, treats and discharges trade waste from a wide range of facilities on site, including some in which radioactive materials are processed. The effluent received by the plant contains trace amounts of radioactivity, some of which is the natural background radioactivity present in all water sources. Treatment includes pH adjustment, if appropriate, and clarification.

5.5 Discharges to the sewer must meet the conditions and limits appearing both in the Water Industry Act Trade Effluent Consent granted by Thames Water Utilities and the Radioactive Substances Act Discharge Authorisation granted by the Environment Agency. The Authorisation places an obligation upon the operator (AWE) to use 'the best practicable means' to minimise the discharges of radioactivity to the environment.

5.6 Levels of radioactivity (alpha and beta) in the discharges are generally up to several times the natural background activity in local surface waters, but are still well below the Guideline Levels for long term drinking water recommended by the World Health Organisation (WHO). The tritium concentration is comparable to that found in local surface waters, far below its WHO Guideline Level for long term drinking water.

5.7 The treated effluent is consented (and analysed) for many non-radioactive factors, including:

ammoniacal nitrogen
beryllium
cadmium
chlorine
chemical oxygen demand
chromium
copper
cyanide
gold
lead
mercury

nickel
pH
phosphorous
settleable solids
silver
sulphate
zinc

In all cases the discharges meet the consented limits for each of the above determinands.

5.8 Detailed quality data for the effluents appear in Annex 2 (for the site discharges) and in Annex 3 (for the RWTP contribution to the TETP input). Examination of these data shows that they have consistently met the quality requirements (i.e. the limits) set by the regulators. It is only the radioactive constituents of the discharges that are of direct relevance for the RSA Improvement and Additional Information Requirement, but other data are reported as well for the sake of completeness.

5.9 In some cases, but not all, the World Health Organisation (WHO) has recommended a guideline value for long term consumption of drinking water. In all such cases a line is included on the graphs (in green) in Annexes 2 and 3 to show the WHO guideline level in relation to AWE's discharge history.

5.10 In most cases the discharges, as well as meeting the regulatory limits for non-radioactive species, are also below the WHO Guideline Level (where there is one) for long term drinking water. Where this is not so, it is generally because the drinking water guideline is beneath the analytical limit of detection required for demonstration of compliance with the consented discharge limit. Graphs A2.3.3, A2.3.10 and A2.3.12 in Annex 3 plot the limit of detection for each determinand (cadmium, lead and nickel), which is above the WHO guideline in each case, rather than actual values.

5.11 It should be noted that WHO recommends a guideline value only if it deems this necessary to prevent any detrimental effect known to result from excessive ingestion of the substance for which a guideline is introduced. In many cases there is no guideline simply because there is no health detriment for the range of concentrations ever likely to be present.

5.12 It may also be noted that the comparisons made with WHO drinking water guidelines appearing in this report are for effluent discharged solely to a sewer. There is further treatment by, and dilution in, the sewage treatment works before any of the water is released to the wider environment.

6. STEPS TO MINIMISE DISCHARGES

AWE has invested many millions of pounds over the last decade in measures to reduce the radioactivity concentrations and volumes of liquid effluent discharges from the Aldermaston site.

6.1 With regard to radioactivity concentrations, the most important series of initiatives has been the replacement of the previous active effluent treatment plant with the new Radioactive Waste Treatment Plant (RWTP). This included:

- waste minimisation initiatives within waste-producing facilities;
- closure of the plumbed and ducted active effluent collection system which used, by capturing rainwater, to add several fold to the volume requiring treatment as 'active' effluent;
- diversion to trade waste of effluent from sources for which there was no history or credible likelihood of there being a discharge containing significant radioactivity;
- closure of the old treatment plant which used a ferric flocculation process (and the associated discharge route to the River Thames) with replacement by a new plant that uses evaporation followed by reverse osmosis filtration to achieve an extremely high decontamination factor for dissolved and particulate contamination; and
- improvements, as they became available, of sampling and analytical techniques, driving down the achievable limits of detection, thus shifting the monitoring emphasis away from a simple demonstration of compliance toward quantification of actual discharges. (Note, however, that it is still not possible for routine operations to distinguish the contribution made as a result of AWE operations from the contribution present as a result of natural background radioactivity. The discharge reports therefore include both contributions which results in some exaggeration of the radioactive discharges from the site.)

6.2 With regard to reduction of volume of effluent discharges, the most important measure was a campaign to refurbish the piped trade waste collection system. After recognition that infiltration of rainwater and groundwater into the system was adding substantially to the annual volume to be managed and discharged, a campaign was undertaken over several years to re-line the underground pipes. This was accomplished without the need for extensive excavation and was followed by similar refurbishment of the manholes situated at intervals along the pipes. This led to a reduction from ~100,000 m^3/year of trade waste for treatment and discharge to a figure nearer to 35,000 m^3/year.

A further volume reduction (referred to above in 6.1) was given by the closure of the plumbed and ducted active effluent collection system which used, by capturing rainwater, to add several fold to the volume requiring treatment as 'active' effluent. The result is that the RWTP discharges only about 1,000 m^3/year into the trade waste system, much less than the 7,000 m^3/year that would have resulted from retention of the piped active effluent collection system.

7. COMPARISON TO WORLD HEALTH ORGANISATION GUIDELINES

7.1 Particularly in Section 4 and Annex 3, information is given in this document concerning the effluent discharged into the trade waste system from the Radioactive Waste Treatment Plant (RWTP), effluent which is not discharged directly into the environment from the plant. This detail of information is given in spite of the fact that the RWTP discharge is only a minor contributor, perhaps 3% by volume and radioactivity, to the effluent total received by the Trade Effluent Treatment Plant (TETP). However, the reasons for emphasising the importance of this contribution are:

- this stream, prior to replacement of the previous ferric flocculation plant, was the major site contributor to the overall aqueous discharges of radioactivity. Following the introduction of the RWTP, there is now very little contribution to the overall site discharge. The change is therefore fundamental for enabling AWE to assert now that its overall aqueous discharges consistently meet the WHO guidelines (or screening levels) for radioactivity in drinking water; and
- the steps taken when transferring from the ferric flocculation process to the RWTP included elimination of the unnecessary collection, treatment and discharge of ~6,000 m^3/year of rainwater and groundwater. This is a much smaller discharge volume reduction than was achieved by re-lining the trade waste drains, but is nonetheless significant.

Annex 3, like Annex 2, includes data about non-radioactive and radioactive effluent contaminants. The purpose of this is to provide a wider perspective on the overall quality of effluent discharged from the Aldermaston site than can be achieved by consideration of radioactivity alone.

7.2 It is the TETP, however, that is the AWE Aldermaston channel for discharge of aqueous waste from the site into the sewer and hence into the environment via the Silchester Sewage Treatment Works. It is therefore the TETP on which the Environment Agency has asked AWE to focus concerning the radioactive content of the discharges and this section of the report addresses this issue. Relevant data are in Annex 2, Sections A2.1 about volume, and A2.2 about activity concentrations.

Figures A2.2.1 to A2.2.3 show the record of radioactivity concentrations – alpha, beta, and tritium – in TETP discharges for the years 2004 to 2007 inclusive. With just two exceptions (see notes under Figures A2.2.1 and A2.2.2), and with one of these being attributable simply to naturally occurring radioactivity, all discharges have been below the relevant concentration guidelines recommended for drinking water by the World Health Organisation. Average concentrations have been small fractions of the guidelines.

8 CONCLUSIONS

8.1 AWE has invested considerably to:

- replace the previous radioactive liquid effluent treatment plant with the new Radioactive Waste Treatment Plant, and to replace the old, installed, active effluent collection system with suitable effluent container collection arrangements; and
- re-line the drains and manholes of the trade waste collection system.

These changes have had led to substantial and beneficial reductions for both the amounts of radioactivity discharged from the site in aqueous effluent, and the minimisation of volumes.

8.2 The changes have been achieved whilst also, almost without exception, maintaining alpha, beta and tritium activity concentrations (Bq/m^3) below the appropriate World Health Organisation recommended guidance levels for drinking water.

8.3 The obligation is placed on AWE through the Radioactive Substances Act waste disposal authorisation to apply 'the best practicable means' to minimise the volume and activity of waste disposals. This is a fundamental requirement of the authorisation and it means that there has been, and will continue to be, a continuous pressure within AWE to minimise the use of water in any way that might give rise to disposals of radioactive effluent. Waste minimisation is part of the entrenched culture of how AWE goes about its business. Over time it will lead to further volume and activity reductions, though these are not likely to be so large in proportion as those achieved over the last 5 years.

8.4 Requirement 5 of Schedule 9 of RSA Authorisation BZ1993 is that:

> '*The Operator shall undertake a programme of work to identify the means to minimise the radioactive aqueous effluent discharged into the environment by use of the route to the Silchester Sewage Works with the end point of determining whether it will be possible to ensure that the activity of the discharge should be equal to, or less than, the World Health Organisation screening levels for Drinking Water.*'

This report describes the work carried out directly linked to this Requirement and provides evidence for the benefits achieved. Almost without exception (and with only a single exception since closure of the discharge route to the River Thames early in 2005), the activity of AWE's aqueous discharges to the Silchester Sewage Works are '*equal to, or less than, the World Health Organisation screening levels for Drinking Water.*'

8.5 AWE has thus fulfilled Requirement 5 and, in addition, has shown the aspiration it expresses to have been realised already.

8.6 New facilities already planned for the site have been considered. None is expected to affect these conclusions.

8.7 However, the TETP has a projected remaining life of 5 years before major refurbishment or replacement. One option then could be to discontinue use of the plumbed collection system and, like the RWTP, to move completely to containerised effluent collection. This would have the merit of eliminating all groundwater infiltration and the associated effluent dilution, but no assessment has yet been made of what this might mean for radioactivity concentrations in the collected effluent. It could be, therefore, that AWE will then have to discuss with the Environment Agency the need to revert to annual discharge limits.

9 RECOMMENDATION

AWE should open a dialogue with the Environment Agency with the objective of amending the terms under which radioactive aqueous waste is authorised for discharge from AWE Aldermaston. The objective should be to replace the present annual limits (currently expressed as integrated totals of becquerels for alpha/beta/tritium) with concentration limits for each discharge batch based on World Health Organisation drinking water guidance levels (expressed as becquerels per cubic metre).

REFERENCES

1. Water Industry Act 1991 Consent to the Discharge of Trade Effluent, ref: TSIL0203, 30th November 2004.
2. AWE Aldermaston: Disposal of Radioactive Waste from Nuclear Site – Certificate of Authorisation, February 2007. Authorisation Number: BZ1994, Schedule 9.
3. Water Resources Act 1991 (as amended by The Environment Act 1995) Section 88 Consent to Discharge from Outfall 13, North Ponds, ref: W/WR957, 28th February 2005
4. Ministry of Defence Sustainable Development and Environment Manual JSP418, April 2005 (see JSP418, Vol 2, Leaflet 17)
5. AWE Compendium of Company Policies, ref: AWE/DSDG/A/PS/AD/011, August 2007
6. AWE Corporate Sustainability Plan, December 2007
7. AWE Energy Strategy, ref: EDMS1/800C5D74/B/SUG02, June 2006
8. AWE Aldermaston – Utilities Strategic Plan, ref: EDMS1/800BC66D/B/UTA21, November 2005
9. AWE Integrated Waste Strategy 2008, ref: AWE/DSDG/B/RP/AD/1970, March 2008

DISTRIBUTION

AWE: via Intranet (Assurance/Regulatory Compliance/Consents & Authorisations)

Non-AWE: Environment Agency, Wallingford

Annex 1

History of Radioactive Aqueous Waste Limits and Discharges for AWE Aldermaston

Table 1: History of Radioactive Aqueous Waste Limits

	Limits for the Years specified			
	1994-2000	2000-2005	2005-2007	2007 to present
Alpha	250 MBq	100 MBq	40 MBq	10 MBq
Beta	450 MBq	180 MBq	120 MBq	20 MBq
Tritium	50G Bq	100 GBq	50 GBq	25 GBq

Notes:

1. Throughout the period 1994-present AWE Aldermaston has discharged radioactive aqueous waste to the sewer. From 1994-2005 the site made additional discharges via a pipeline directly to the Thames (the 'Pangbourne Pipeline', which was closed in 2005). The figures in each row in the Table above are for the summed limits for the site, i.e. for the sum of the limits for the two available discharge routes for the years 1994-2005, but for the sewer alone from 2005.
2. Actual discharges of radioactivity in aqueous discharges from the Aldermaston site have always been substantially less than the appropriate limit see Table 2.

Table 2: History of Actual Radioactive Aqueous Discharges

	Average Annual Discharges for the Years specified			
	1994-1999	2000-2004	2004-2006	2007
Alpha (MBq)	22.4	11.2	5.1	3.2
Beta (MBq)	48.6	16.8	10.7	11.9
Tritium (GBq)	7.44	11.3	4.76	0.88

Note:

1. Throughout the period 1994-present AWE Aldermaston has discharged radioactive aqueous waste to the sewer. From 1994-2005 the site made additional discharges via a pipeline directly to the Thames (the 'Pangbourne Pipeline', which was closed early in 2005). The figures in each row of the Table above are for the summed discharges for the site, i.e. for the sum of the discharges via the two available discharge routes for the years 1994-2004, but via the sewer alone from early in 2005.

Annex 2

Data for Effluent from the Trade Effluent Treatment Plant

A2.1 Annual Volume of Treated Effluent

Discharges to Silchester Sewage Treatment Works	
Year	**Volume (m^3)**
2000	64035
2001	40333
2002	26272
2003	27948
2004	30627
2005	24843
2006	34191
2007	40563

Notes for A2.1:

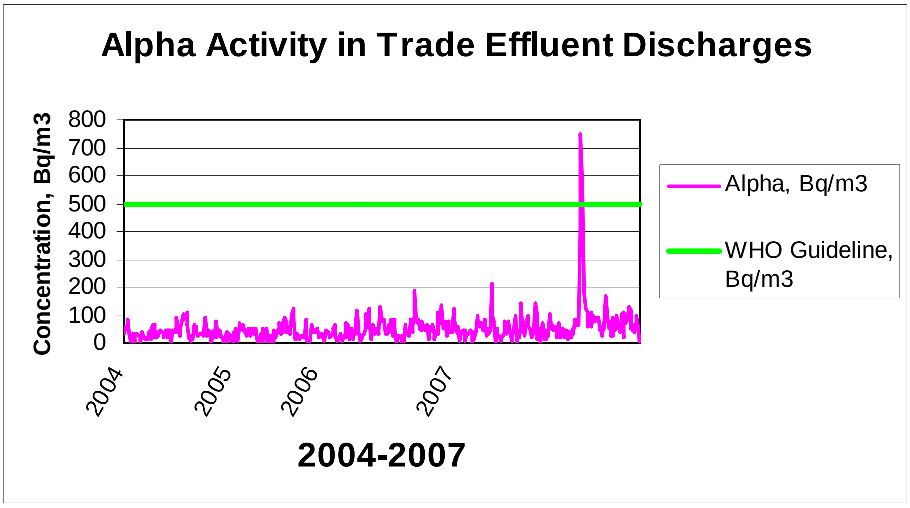
1. The fall in volume between 2000-2002 was an effect of measures to reduce the infiltration of rainfall and groundwater.
2. The rise in volume 2006-2007 was because effluent from the Boilerhouse was diverted to Trade Waste while remedial work was carried out to the foul drain disposal route.
3. For the long term, annual disposals via Trade Waste are expected to be in the region of 35,000 m^3 (if it is assumed there is negligible reduction through re-use).

A2.2 Radioactive Characteristics of Treated Effluent

Disposals to Silchester Sewage Treatment Works from the Aldermaston Trade Effluent Treatment Plant are subject to the authorisation for disposal of radioactive wastes, reference BZ1994. Current annual limits for disposal of total activity are recorded in Annex 1 (10 MBq (total) alpha, 20 MBq (total) beta excluding tritium, and 25 GBq tritium). These limits have been in effect only since March 2007. The graphs below show the discharge record for the period 2004-2007 in terms of concentrations of radioactivity per cubic metre of effluent (Bq/m^3). It is apparent that that there were two abnormal discharge concentrations, one (affecting two consecutive batch discharges) of alpha activity in 2007 (see note beneath the Alpha Activity graph, A2.2.1), and one for beta activity in 2004 (see note beneath the Beta Activity graph, A2.2.2).

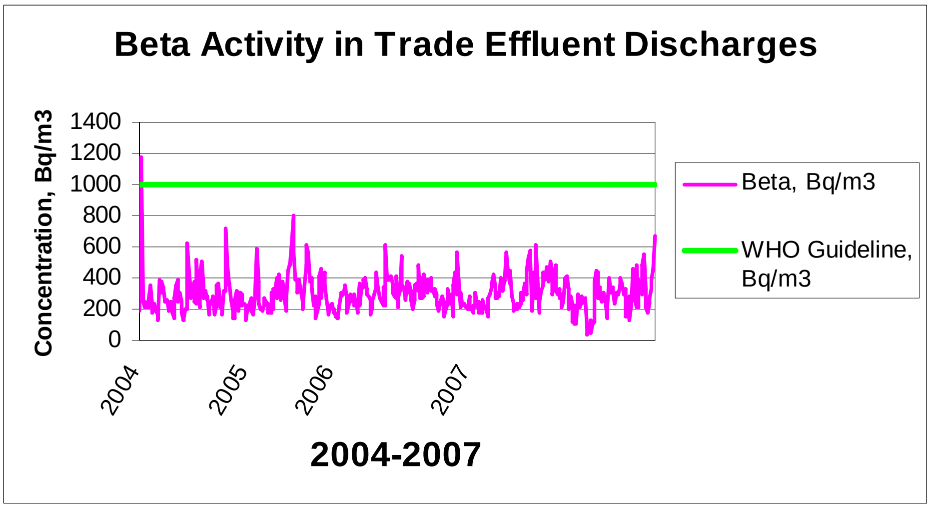
Also shown in each graph is the relevant World Health Organisation (WHO) recommended guideline for a maximum long term concentration of that category of radioactivity in drinking water.

A2.2.1 Discharge of Alpha Activity from Trade Effluent Treatment Plant



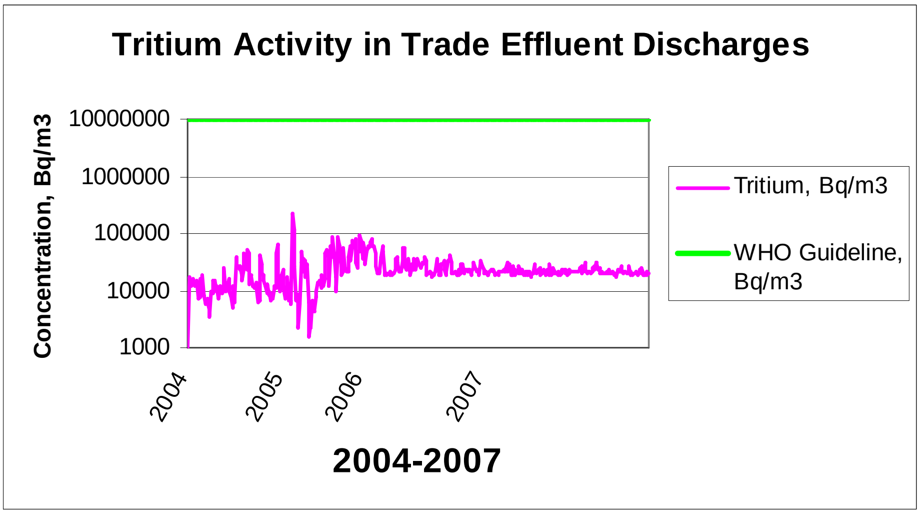
Note: An Abnormal Event in July 2007 resulted in the transfer of additional alpha activity into the Trade Waste system. The addition was recognised at once, before any discharge was made from site and, although there was no reasonably practicable way of preventing the discharge, the system was managed so that all discharges were well within the discharge limit authorised by the Environment Agency. Apart from the two discharge batches most affected by this incident, alpha activity concentration in discharges in the period 2004-2007 has always been less than the drinking water guideline of 500 Bq/m^3 for alpha activity recommended by the World Health Organisation. The average concentration for each year (2004-2007) has remained well below 100 Bq/m^3, i.e. less than 20% of the WHO guideline.

A2.2.2 Discharge of Beta Activity from Trade Effluent Treatment Plant



Note: At the start of 2004 there was an elevation of the beta activity in a single batch discharge from the TETP. The cause was a higher than usual concentration of the naturally occurring radioactive potassium isotope, potassium-40, in the effluent received by the TETP. Apart from this single instance, all discharges in 2004-2007 were below the World Health Organisation guideline of 1000 Bq/m^3 for beta activity recommended for drinking water. The average concentration for each year (2004-2007) has been about 300 Bq/m^3, i.e. about 30% of the WHO guideline.

A2.2.3 Discharge of Tritium Activity from Trade Effluent Treatment Plant



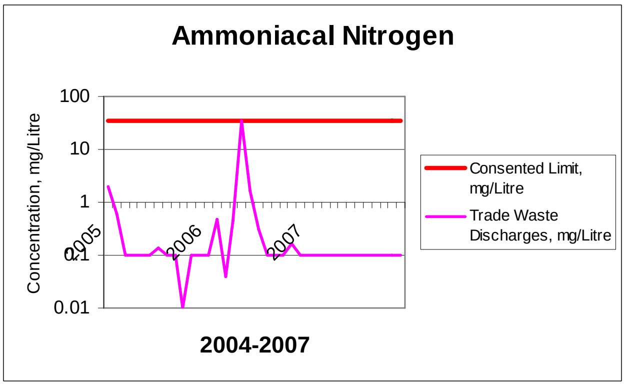
Note: All discharges in 2004-2007 were below the World Health Organisation guideline of 10,000,000 Bq/m^3 for beta activity recommended by the World Health Organisation. The average concentration for each year (2004-2007) has been about 30,000 Bq/m^3, i.e. about 0.3% of the WHO guideline.

A2.3 Non-Radioactive Characteristics of Treated Effluent

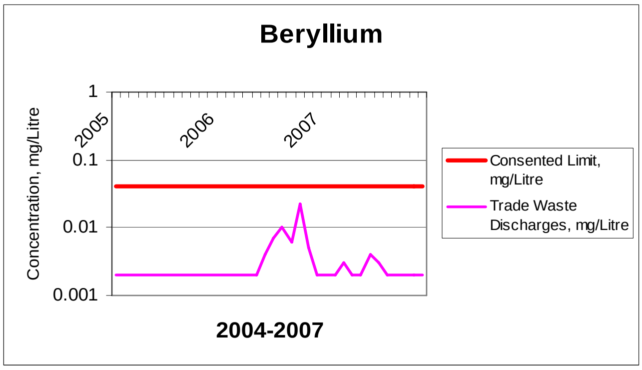
Discharges have to comply with the limits and conditions provided by the Water Industry Act Consent to discharge trade effluent into a public sewer. AWE's performance against the requirements is shown by the following graphs. Where available, the recommended maximum value for long term consumption of drinking water is also shown (in green). In addition, the pH record is plotted.

Note that in a few of the graphs, e.g. A2.3.6 and A2.3.7, the reported concentrations appear to be above those recommended by the World Health Organisation as guidelines for drinking water. This may reflect the fact that in some cases, although the analytical technique applied to the discharges is adequate for demonstration of compliance with the relevant consented level, the technique is insufficiently sensitive to record the very low concentrations actually present in the discharges.

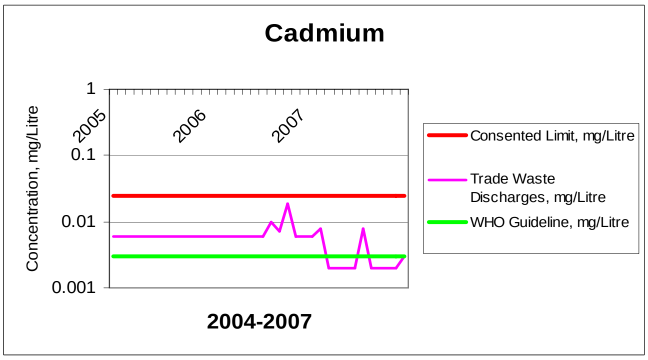
A2.3.1 Ammoniacal Nitrogen in Effluent from Trade Effluent Treatment Plant



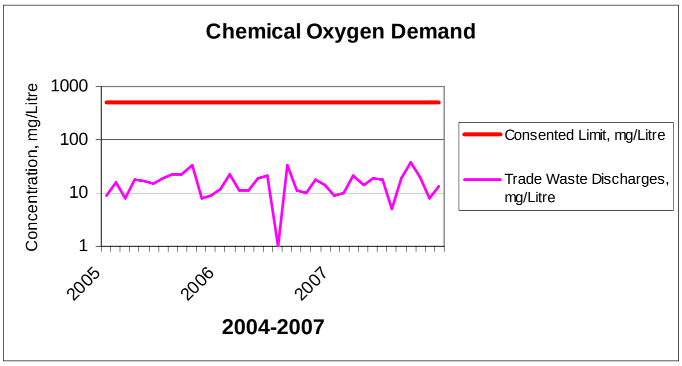
A2.3.2 Beryllium in Effluent from Trade Effluent Treatment Plant



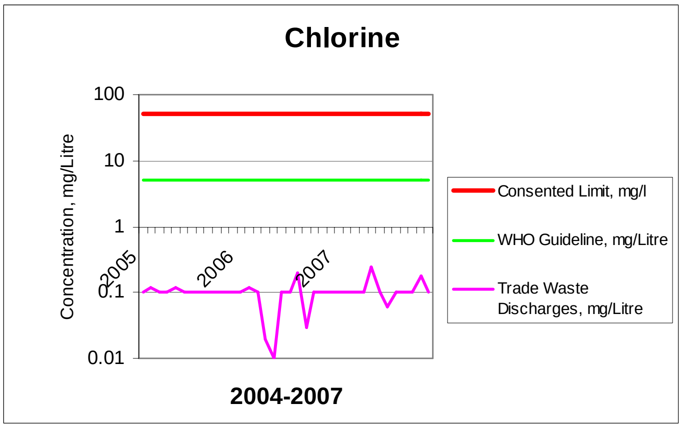
A2.3.3 Cadmium in Effluent from Trade Effluent Treatment Plant



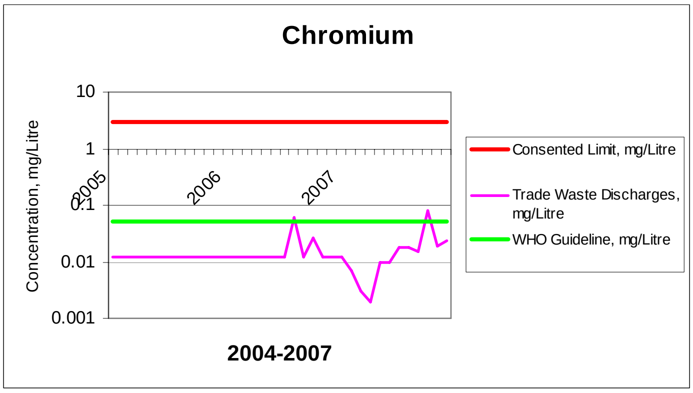
A2.3.4 Chemical Oxygen Demand in Effluent from Trade Effluent Treatment Plant



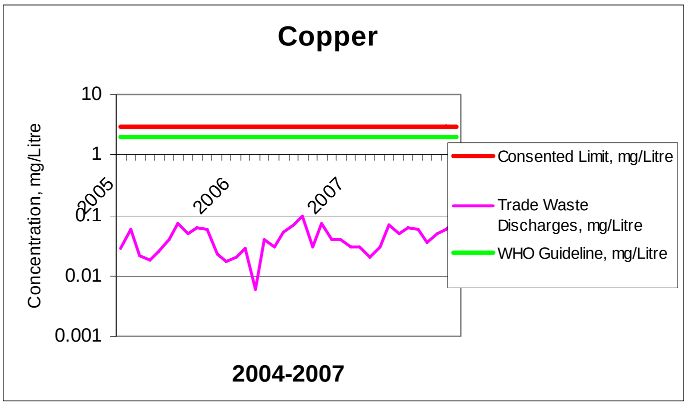
A2.3.5 Chlorine in Effluent from Trade Effluent Treatment Plant



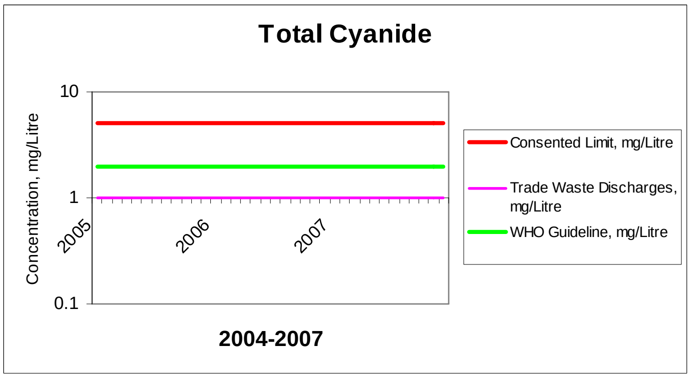
A2.3.6 Chromium in Effluent from Trade Effluent Treatment Plant



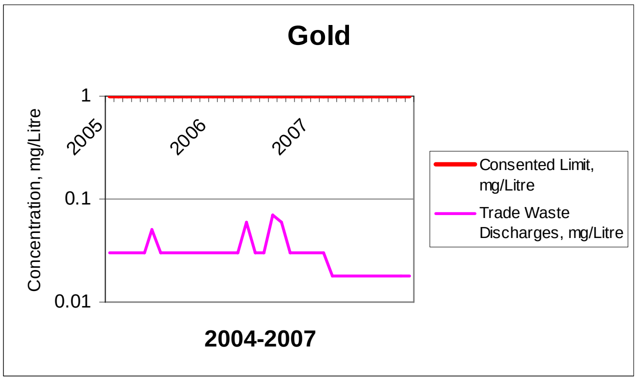
A2.3.7 Copper in Effluent from Trade Effluent Treatment Plant



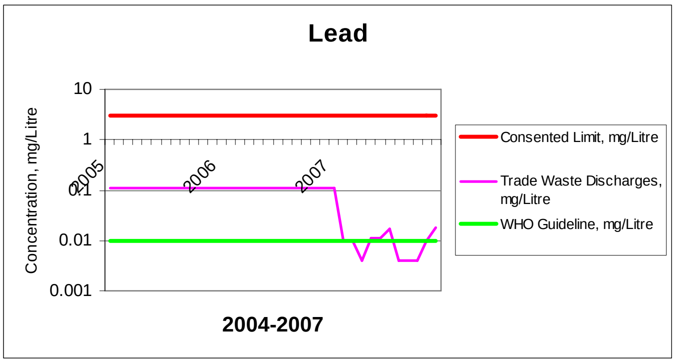
A2.3.8 Cyanide in Effluent from Trade Effluent Treatment Plant



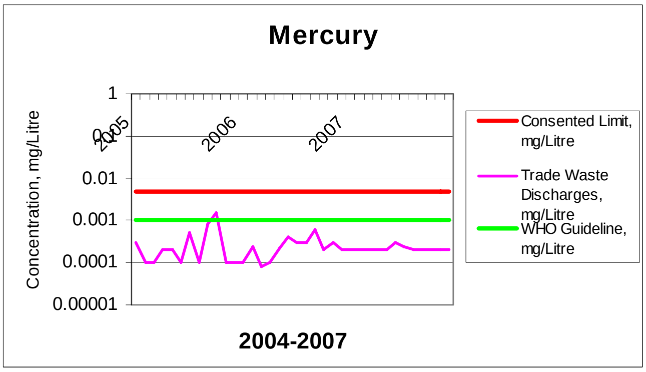
A2.3.9 Gold in Effluent from Trade Effluent Treatment Plant



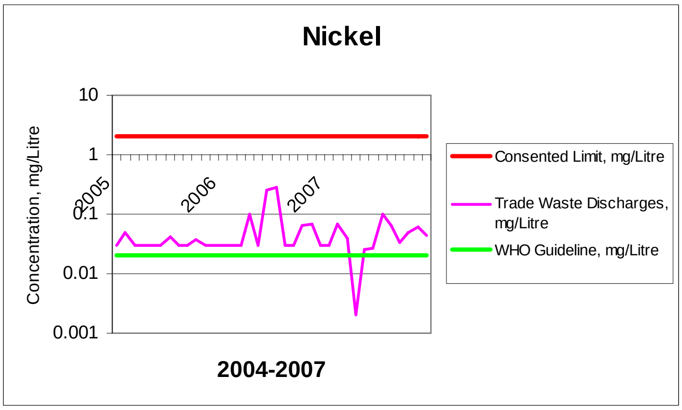
A2.3.10 Lead in Effluent from Trade Effluent Treatment Plant



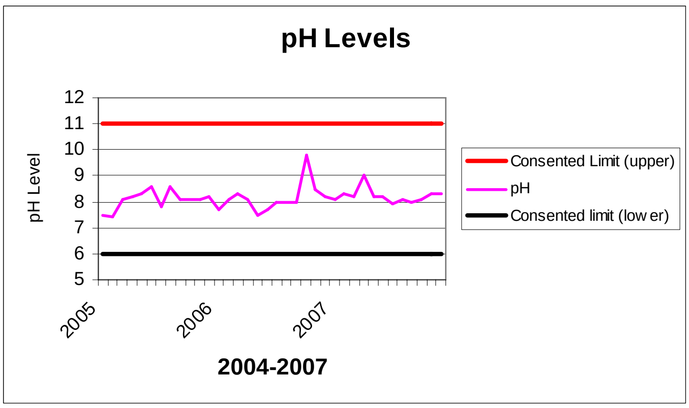
A2.3.11 Mercury in Effluent from Trade Effluent Treatment Plant



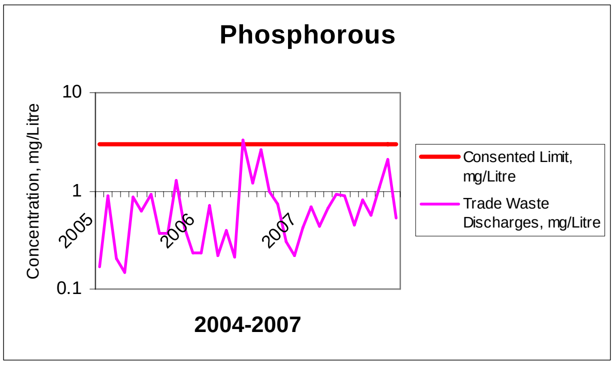
A2.3.12 Nickel in Effluent from Trade Effluent Treatment Plant



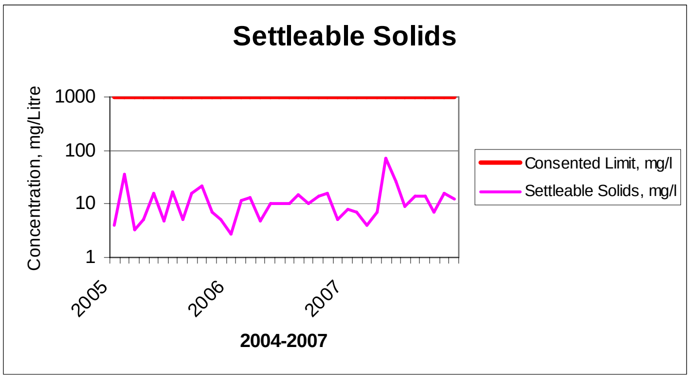
A2.3.13 pH of Effluent from Trade Effluent Treatment Plant



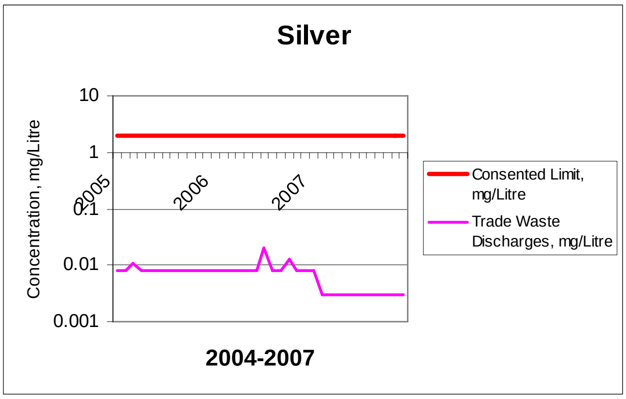
A2.3.14 Phosphorous in Effluent from Trade Effluent Treatment Plant



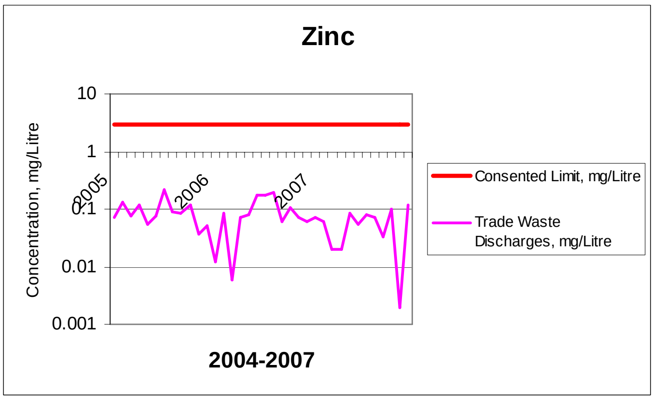
A2.3.15 Settleable Solids in Effluent from Trade Effluent Treatment Plant



A2.3.16 Silver in Effluent from Trade Effluent Treatment Plant



A2.3.17 Zinc in Effluent from Trade Effluent Treatment Plant



Annex 3

Data for Effluent from the Radioactive Waste Treatment Plant (RWTP)

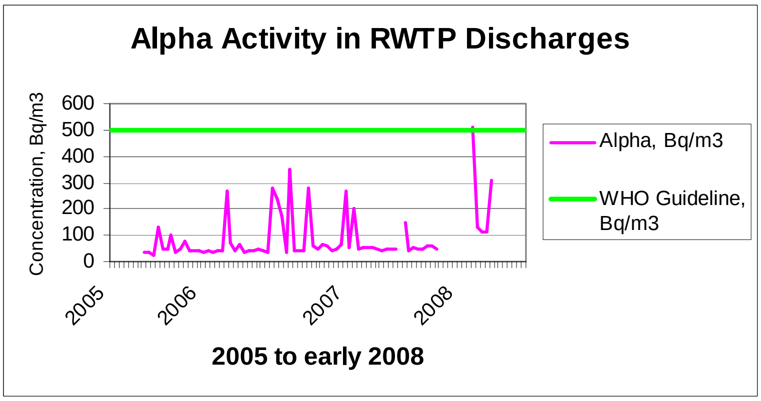
A3.1 Annual Volume of Treated Effluent

The plant was out of operation from August 2007 to March 2008, but discharged approximately 1,000 m^3 of effluent per year in each of the two years before.

A3.2 Radioactive Characteristics of Treated Effluent

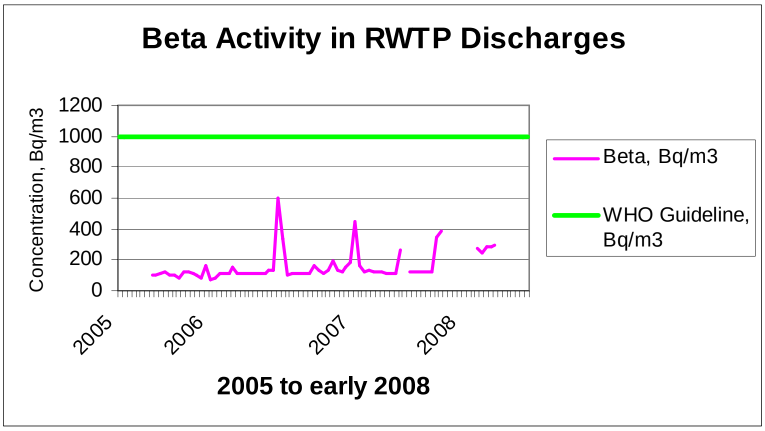
Graphs A3.2.1 to A3.2.3 show the record for 2005 to mid-2008 of radioactivity in discharges made by the Radioactive Waste Treatment Plant (RWTP). No regulatory limits apply directly to the radioactivity in these discharges (although such limits do of course apply to the Trade Waste Plant through which the RWTP discharges must pass). Therefore the most useful reference levels for the discharge limits are those taken from the World Health Organisation (WHO) guidelines for radioactivity in drinking water – these are shown in green on each of the graphs.

A3.2.1 Discharge of Alpha Activity from the Radioactive Waste Treatment Plant



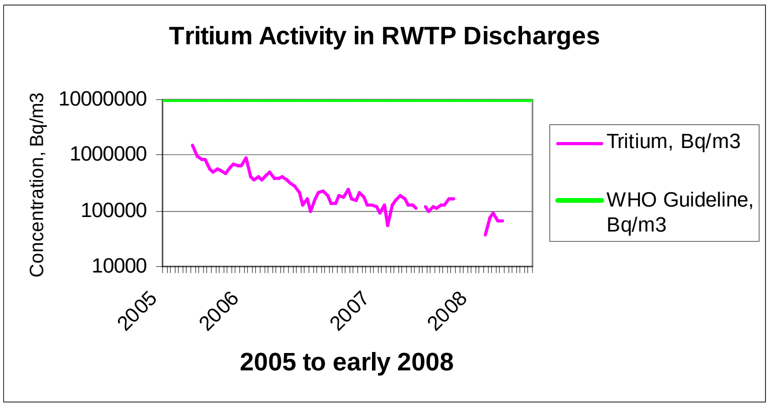
Note: With one marginal exception when the plant re-started after a period out of service, the alpha activity concentration in discharges has always been less than the drinking water guideline of 500 Bq/m^3 for alpha activity recommended by the World Health Organisation. The average concentration has remained below 100 Bq/m^3, i.e. less than 20% of the WHO guideline.

A3.2.2 Discharge of Beta Activity from the Radioactive Waste Treatment Plant



Note: The beta activity concentration in discharges has always been less than the drinking water guideline of 1,000 Bq/m^3 for beta activity recommended by the World Health Organisation. The average concentration has remained below 150 Bq/m^3, i.e. less than 15% of the WHO guideline.

3.2.3 Discharge of Tritium Activity from the Radioactive Waste Treatment Plant

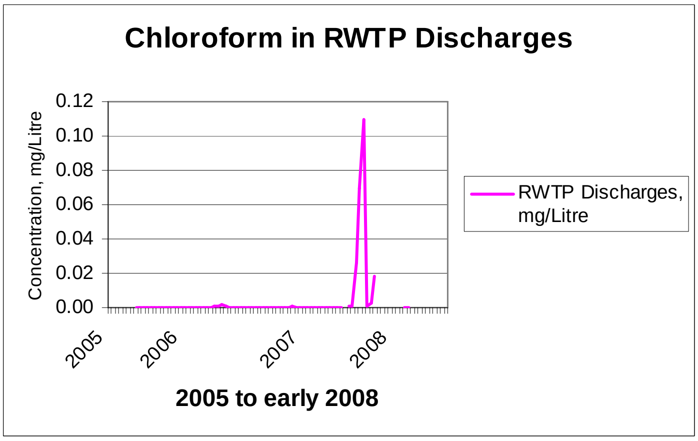


Note: The tritium activity concentration in discharges has always been less than the drinking water guideline of 10,000,000 Bq/m^3 for tritium activity recommended by the World Health Organisation. The average concentration has been 320,000 Bq/m^3, i.e. about 3% of the WHO guideline.

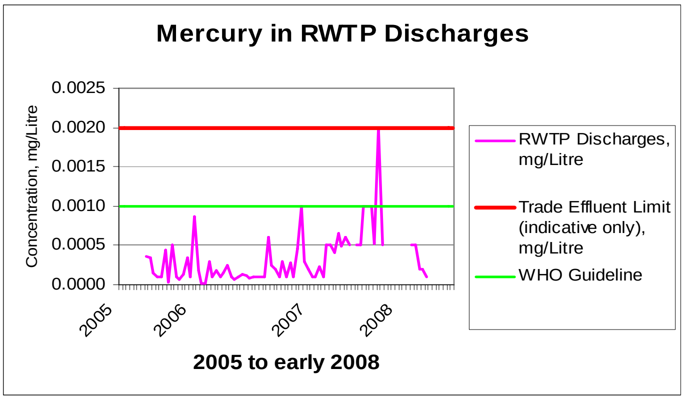
A3.3 Non-Radioactive Characteristics of Treated Effluent

Note that there is no consent limiting the effluent quality parameters for discharges from the RWTP to the Trade Waste system (although such limits do of course apply to the Trade Effluent Plant, through which the RWTP discharges must pass – a few of these limits are shown below as references for comparison). The only concern is to avoid introduction of materials to the TW system that could inhibit the performance of the Trade Effluent Treatment Plant. A result is that only a limited number of analytical determinands are monitored, many of them being organic compounds. The analytical result is almost always below the lower limit of detection of the measurement technique. Therefore only a few representative graphs are included below.

A3.3.1 Chloroform content of Treated Effluent Discharged from the RWTP

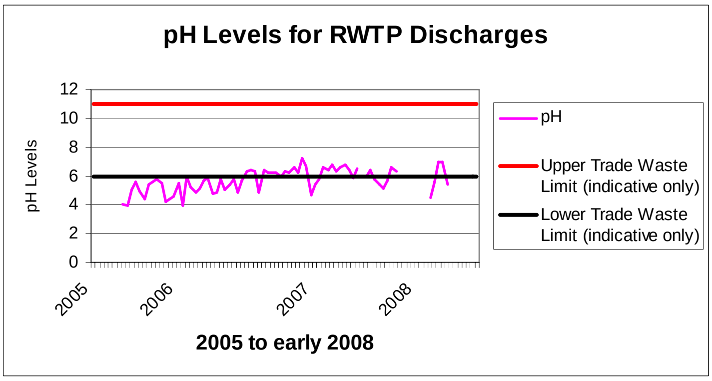


A3.3.2 Mercury content of Treated Effluent Discharged from the RWTP



Note: The 'limit' shown on this graph actually refers to off-site discharges of treated trade effluent and it is only shown as a reference. There is no formal limit for discharges into the on-site trade effluent collection system. Discharges from the RWTP are greatly diluted by other trade effluent before further treatment and subsequent discharge from site.

A3.3.3 pH of Treated Effluent Discharged from the RWTP



Note: The limits actually apply to discharges made from the site via the Trade Waste system and not to the RWTP discharges into the Trade Waste collection system. To facilitate management of the effluent in the Trade Waste Treatment Plant, however, it is common for a pH adjustment to be made before discharge from the RWTP to reduce the acidity.

A3.3.4 Trichloroethylene content of Treated Effluent Discharged from the RWTP