Kildare County Council
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Kerdiffstown Landfill Remediation Project

Kildare County Council

Environmental Impact Assessment Report (EIAR) Volume 4 of 4: Appendices (Part 4)

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Appendices List

Appendix No.	Title
Part 1	
A4.1	Road and New Site Access Design Technical Note
A4.2	Assessment of Predicted Settlement
A4.3	Capping and Waste Slope Stability Assessment
A4.4	Leachate Management Plan
A4.5	Landfill Gas Management Plan
A4.6	Surface Water Management Plan
A4.7	Earthworks Summary Technical Note
A4.8	Landscape Masterplan Statement
A4.9	Accident Prevention and Emergency Response Plan
A4.10	Monitoring and Control Plan
A6.1	EIA Scoping Letter Template
A6.2	EIA Scoping Submissions
A7.2	Dispersion Modelling Assessment Methodology
A7.2	Laboratory Analysis Certificates for Dust
A7.3	Laboratory Analysis Certificates Trace Gases
A7.4	2016 VOC Emission Survey
A7.5	October 2016 Dust and Odour Report
A7.6	2016 Flare Emissions Monitoring Report
A7.7	SKM Enviros 2013 Odour Control Plan
A7.8	SKM Enviros 2013 Outline Life Cycle Assessment
A7.9	Dispersion Modelling Assessment Results
A8.1	Noise Monitoring Survey Report
A8.2	Calibration Certificates
A9.1	Visual Impact Appraisals at Selected Viewpoints
A10.1	Impact Assessment and the Cultural Heritage Resource
A10.2	Geophysical Survey
A10.3	Recorded Monuments and Places within the Surrounding Area
A10.4	Stray Finds within the Surrounding Area
A10.5	Legislation Protecting the Archaeological Heritage Resources
A10.6	Legislation Protection of Architectural Heritage Resource
A10.7	Recorded Structures and NIAH Structures within the Surrounding Area
A11.1	Legislation, Policy and Guidelines
A11.2	Zones of Influence Informing the Assessment
A11.3	Bat Conservation Ireland Records
A11.4	Photos
A11.5	Flora Species List
A11.6	Bat Survey Results
A11.7	Breeding Bird Survey Results
A11.8	Frog Derogation Licence 2017
A11.9	Artificial Sand Martin Bank Creation
A11.10	Appropriate Assessment Screening Report
Part 2	
A12.1	Groundwater and Surface Water Monitoring Report – Quarter 1 2017
Part 3	
A12.2	Groundwater and Surface Water Monitoring Report - December 2016
Part 4	
A12.3	Groundwater DQRA Technical Note
A13.1	Flood Risk Assessment
A13.2	Monitoring Details
A13.3	Biological Q-rating Assessment of the Morell River
A13.4	EPA Hydrotool Report for the Morell River
A14.1	Traffic and Transport Assessment
A14.2	TRICS Output Files
A14.3	Road Safety Audit

Appendix A12.3 Groundwater DQRA Technical Note

Kerdiffstown Landfill Remediation Project

Kildare County Council

Groundwater DQRA Technical Note

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Contents

1. Introduction

1.1 Introduction and Objectives

This technical note provides details of groundwater detailed quantitative risk assessments (DQRAs) undertaken to assess the potential impacts to groundwater and associated surface water receptors from the Kerdiffstown landfill site in its current condition and following the proposed remediation works. The assessment has been undertaken for each of the five identified zones at the site which contain waste material.

The principal objective of the DQRAs is to quantify the effects of the proposed remediation of the Kerdiffstown landfill site on the water receptors, including assessing the likely effects of capping the site, one benefit of which is to reduce rainwater recharge into the wastes.

1.2 Background

Kerdiffstown landfill is a former sand and gravel quarry which has been progressively backfilled with wastes by a variety of operators from the 1950s onwards. Details of these earlier wastes are not known. However, the site was then operated as a licenced waste facility between 1995 and 2010 and was effectively abandoned in mid-2010 in an unsecured condition.

Since completion of the environmental liabilities assessment in 2010, Jacobs has been working with the EPA and KCC and was appointed as Framework Contractor in February 2013. Over the years groundwater monitoring boreholes have been installed within and outside the site to determine the extent of any groundwater contamination associated with the landfilled waste. Jacobs has completed groundwater and surface water monitoring on a monthly basis with the most recent report being produced following the six-monthly monitoring in December 2016 (Reference 1).

Reference 1 describes the site setting and defines the current groundwater quality data and assesses trends in groundwater quality. The reference also contains a plan showing monitoring borehole locations. The reference also includes details of the groundwater level monitoring and the local groundwater regime. Groundwater quality and level data are not provided in this technical note and if required Reference 1 should be read to gain an understanding of groundwater quality and groundwater levels at the site.

The most recent site investigation was undertaken in the autumn of 2016. Factual data from this investigation are provided in Reference 2 and relevant data from the investigation are considered in the geology and hydrogeology chapter of the Environmental Impact Assessment Report (EAIR, Reference 3).

The Kerdiffstown Landfill site has been split into several zones, each zone having characteristic properties in terms of historical waste disposal and site features. Descriptions and conceptualisation of each zone are provided in the Preliminary CSM Technical Note (Jacobs, Reference 4). For each zone, conceptual Site Models (CSMs) have been defined based on zone specific waste type, geology and hydrogeology.

The receptors have been identified as the groundwater within the sand and gravels or overburden deposits, the limestone aquifer (thought to be restricted to the upper 5m to 10m of weathered bedrock known as the transition zone where fractures are present) and the Morell River which is in hydraulic connection with the groundwater in the overburden.

1.3 Justification for Modelling Approach and Software

The modelling approach adopted for this assessment has used two probabilistic analytical software packages, LandSim and RAM3. An outline of these modelling packages is provided in the following sections, but for more detail Reference 5 and Reference 6 should be read.

Previous modelling of Zone 1 (Reference 7) utilised the LandSim software package which is modelling software developed by England's Environment Agency to assess the impacts from typical landfill sites. However, for the purpose of this assessment, the RAM3 modelling package has been used to model Zone 1 as it offers more flexibility in terms of the contaminant sources, pathways and receptors to simulate the pathway from the saturated waste as well as that from recharge passing though the waste and unsaturated zone into the overburden groundwater.

The RAM3 software package has also been used for modelling impacts from Zones 2A, 2B and 4 as these have characteristics similar to Zone 1 with the presence of waste beneath the water table (except for Zone 2A) and having no engineered liner at the base of the waste.

For Zone 3, the lined landfill cell has a basal liner and, following remediation, would be completed with an engineered cap. Wastes in this zone are also above the water table and as such Zone 3 is better suited to be modelled using the LandSim program.

1.3.1 Monte Carlo Probabilistic Risk Assessment

The Monte Carlo approach to probabilistic risk assessment scientifically addresses the case where a parameter may have a range of values. In this approach, parameters which have a range of values are considered in turn. Instead of assigning a single value to each parameter, a combination of data and expert judgement are used to define the distribution of possible values that the parameter might take. This allows for the possibility that a given parameter might, at this site, have a particularly low or high value, but would also incorporate the knowledge of how likely these extreme values are. Once all the parameters with a range of values have been associated with a probability distribution in this way, the model is evaluated many times. In each simulation, values are chosen for each parameter with a range of values by sampling a random value from its probability distribution. The distribution of results from the model represents our understanding of the uncertain consequences of our range of values used for the input parameters.

This approach applies to both LandSim and RAM3.

1.3.2 RAM Methodology

RAM is an Excel spreadsheet based modelling package published by ESI Limited that provides an assessment of risk using the source-pathway-receptor methodology. In this approach, contaminant migration pathways are identified from the conceptual model. The corresponding risk of groundwater contamination is evaluated by considering the three components in sequence, with the contaminant release from the source providing the input flux to the pathway and the contaminant flux from the pathway providing the contaminant load to the receptor.

The source of the contaminants is modelled based on leachate from the contaminated material. The pathway is modelled as an advection-dispersion-retardation-decay transport model, solved using a Laplace transform solution method. The receptor can be an aquifer, abstraction borehole or a river, with for example, dilution in a river being considered. The analysis along each pathway takes account of the geometry of the pathway, but is essentially one-dimensional, with a simple description of the physical parameters affecting the contaminant migration along the pathway.

The sources, pathways and receptors determined in the CSM are entered into RAM as a graphical representation as shown in Figure 1 for Zone 1.

The spreadsheet model represents the key properties of the migration pathway as a one-dimensional flow geometry, and through the Monte Carlo method, it is able to quantify the outcome where a range of values might apply for any given parameter. Results from the RAM models have been reported at the 50%ile and 95%ile level.

1.3.3 RAM3 Model Calibration and Validation

The RAM3 models for each zone have been calibrated using groundwater quality data collected in ground investigations and monitoring works. A key consideration in the calibration of the models is the range of source concentrations which are input to each model. Source concentrations used for each zone have been determined from consideration of the leachate quality obtained from Zone 3 between 2010 and 2016, the results of leaching tests on soil samples collected in the 2016 ground investigation and from the concentrations of the determinands measured in groundwater adjacent to each zone.

For each model, the calibration has considered the concentrations in groundwater in the overburden deposits at a point 10m from the edge of the zone and in the groundwater adjacent to the surface water receptor (Morell River). Predicted concentrations in the river, following dilution, are provided in the surface water chapter of the EIA.

Each zone has been modelled for substances that have been identified as being elevated in groundwater and leachate at the site which have a range of physiochemical properties. This includes organic and inorganic substances as shown in Table 1.1.

Table 1.1 – Substances Considered in the Assessment

Substance	Mobility	Degradation Rate	Rationale for including in the assessment
Inorganic substances			
Chloride	Highly mobile with no retardation.	Substance does not degrade	Chloride is a key contaminant of landfill leachate and is identified as being elevated in groundwater at the Kerdiffstown site.
Ammoniacal nitrogen	Moderate mobility with low retardation	In the model it is assumed that there is no degradation, although under ideal circumstances ammoniacal nitrogen can degrade to nitrate	Ammoniacal nitrogen is a key contaminant of landfill leachate and is identified as being elevated in groundwater at the Kerdiffstown site.
Nickel	Low mobility with high retardation	Substance does not degrade	Nickel is identified as being elevated in the leachate collected in Zone 3, although relatively low concentrations are identified in groundwater (for example up to 0.079mg/l .in borehole EMW03 at the edge of Zone 1) Leaching test data for samples from Zone 1 also showed relatively low concentrations of nickel ranging from <0.002mg/l to 0.075mg/l.
Zinc	Low mobility with high retardation	Substance does not degrade	Zinc is identified as being elevated in the leachate collected in Zone 3, although relatively low concentrations are identified in groundwater (although up to 0.3mg/l in EMW13 at the edge of Zone 1) Leaching test data for samples from Zone 1 showed moderate concentrations of zinc ranging from 0.0052mg/l to 0.157mg/l.
Organic substance*			
Benzene	Compared to other organic substances, benzene has a relatively high mobility	Moderate degradation rate, with a half-life in the order of a few years	Benzene has a relatively low guideline value and has been detected periodically in the leachate from Zone 3, although generally it is not detected in groundwater.

Substance	Mobility	Degradation Rate	Rationale for including in the assessment
Mecoprop	Compared to other organic substance, mecoprop has a relatively high mobility	High degradation rate, with a half-life in the order of 10s to 100s of days.	Mecoprop has been detected in groundwater at concentrations above the interim guideline value IGV* (IGV).
Phenol	Compared to other organic substance, phenol has a relatively high mobility	High to moderate degradation rate, with a half-life in the order of year.	Phenol has been detected in groundwater at concentrations above the IGV.

* For organic substances, the mobility is related to the organic content of the soils as well as the organic partition coefficient
** IGVs are provided in Reference 8

1.3.4 LandSim Methodology

LandSim allows the computer simulation of leakage from a typical landfill site to be modelled on the basis of key site-specific parameters and the landfill's setting. This includes design of the landfill cap and liner system and the control of leachate levels within the waste.

Few of the input parameters (such as rainfall infiltration, leachate concentrations) are known exactly and therefore a probabilistic model is considered to be the best approach for assessing groundwater impacts. That is because each parameter can be described by a range of possible/probable values incorporating the available information and selecting values for each simulation within this range. During each simulation the parameters are assigned a value from within the defined ranges. After say 1000 iterations, a range of possible predicted leakage or outcome values are obtained and it becomes possible to quantify the likelihood of a certain outcome.

LandSim uses statistical distributions or probability density functions (PDFs) to characterise many of the input parameters. Each time a calculation is carried out, one value from the defined input distributions is chosen by the computer code and, for example, a concentration at the receptor is calculated. Each result is stored such that after repeating the same calculation many times, an output distribution for the concentration at the receptor is obtained. The distribution output is given in terms of percentiles (%iles). These %iles specify the probability with which a certain value (e.g., leakage rate) will not be exceeded. For instance, if the 95%ile of a leakage rate distribution is given as 0.1m^3/day, there is a 95% chance that the actual leakage rate will be below or equal to 0.1 m^3/day. It follows that there is also a 5% chance that the actual leakage rate will be above this. The 50%ile output is viewed as the most likely result from the model. Jacobs considers that the 95%ile output is sufficient to represent a worst case output for the Kerdiffstown site.

1.4 Structure of this Technical Note

This technical note is divided into the models for each zone with source input data shown in a corresponding appendix for each zone. The results output from each model is also presented in the appendices with a summary of the results.

The technical note also provides an assessment of the results and considers the site as a whole, the key issues identified from the models and how this fits in with the remediation of the site.

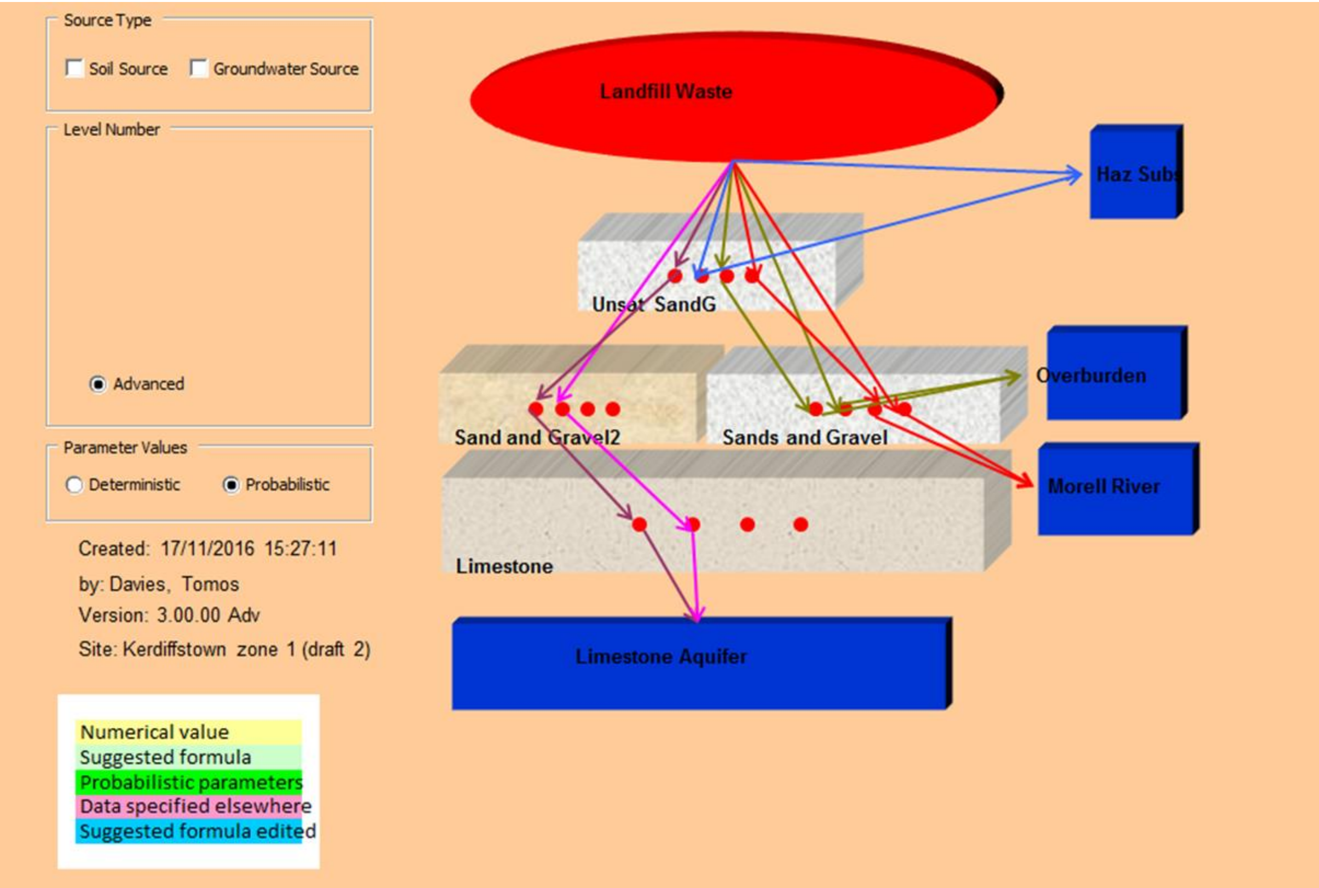
2. Zone 1

2.1 Zone 1 model construction

The CSM for Zone 1 (and other zones) is provided in the Preliminary CSM Technical Note (Reference 4).

RAM has the ability to represent waste sources below and above the groundwater table. This is simulated via the user input of different pathways and a water balance using the modelling software in Advanced Mode. The conceptual breakdown of the CSM for the RAM model is shown on Figure 1.

Figure 1 : Conceptual breakdown of the CSM of Zone 1 for the RAM model



The "Zone 1 Uncapped" model was calibrated using groundwater quality concentrations recorded immediately downgradient of Zone 1, as well as in vicinity of the Morell River. Key parameters used during the calibration process were the source term concentrations and the hydraulic conductivity of the overburden deposits.

Source term concentrations used as model inputs for ammoniacal nitrogen, chloride and metals were derived from available ground investigation data (Zone 1 leachability tests from 2016 and Zone 3 leachate quality data obtained between 2010 and 2016). Source inputs for formaldehyde, mecoprop and phenol were based upon a range of literature values as set out in the Groundwater DQRA Report (Reference 7).

Hydraulic conductivity estimates were obtained from site specific permeability estimates for the overburden deposits and the limestone bedrock.

In addition, partition coefficient (Kd) value estimates were derived from the LandSim manual, with organic partition coefficient (Koc) values for [1]mecoprop, [2]phenol and [3]formaldehyde being derived from literature values. Groundwater head, hydraulic gradient and fraction of organic carbon (foc) values were obtained from local ground investigations and porosity estimates were derived from the LandSim help files. Dry bulk density estimates were obtained from ConSim help files and half-life estimates were derived from various literature sources (from the Environment Agency, US EPA and the LandSim and ConSim help files).

Model inputs are provided in Appendix A.

Following the initial model which represents Zone 1 in its current uncapped state, a further model ("Zone 1 Capped") was created to simulate a cap being placed above the waste. For the capped scenario infiltration rates have been calculated using the RAM software based on the permeability of the cap and assuming that drains are installed around the entire edge of the zone.

It should be noted that a key limitation with RAM is the ability to run the capping scenarios applying an initial phase of open waste infiltration followed by a capped period. The period during which the waste cannot be properly simulated as open waste generates a higher source concentration and a slower decrease in the source term. This generates a level of conservatism which only applies to the capped scenario. This limitation needs to be taken into account when looking at the results obtained and comparing uncapped and capped scenarios.

2.2 Model output and Sensitivity Assessment

Tables 2.1 and 2.2 summarise the predicted peak concentrations at 50%ile and 95%ile for ammoniacal nitrogen in both the uncapped and capped scenarios. Results for the other substances are provided in Appendix A and Figures 2.1 to 2.8 show ammoniacal nitrogen concentrations for the 95%ile results.

Results are reported in Tables 2.1 and 2.2 for:

- Saturated waste : this is the source term concentration within the saturated portion of the waste;
- Overburden 10m from the zone : groundwater concentration within the overburden deposits 10m away from the zone boundary;
- Overburden at the Morell River: groundwater concentration within the overburden deposits adjacent to the Morell River (note this is not the concentration in the river itself, rather the groundwater adjacent to the river. Dilution of the contaminants would subsequently occur within the river); and
- Limestone: groundwater concentration within the limestone aquifer 50m away from the zone boundary.

Table 2.1 : Uncapped Model Results for Ammoniacal Nitrogen in Zone 1

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated waste	401	1	671	1
Overburden 10m from the zone	37	100	98	50
Overburden at the Morell River	27	150	83	80

[1] Environment Agency, 2002. The Effects of Contaminant Concentration on the Potential for Natural Attenuation R&D
[2] Environment Agency, 2008. Compilation of data for priority organic pollutants for derivation of Soil Guideline Values
[3] US EPA RBCA dataset

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Limestone	19	150	67	80

Table 2.2 : Capped Model Results for Ammoniacal Nitrogen in Zone 1

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated waste	387	1	687	1
Overburden 10m from the zone	55	250	124	250
Overburden at the Morell River	50	250	114	250
Limestone 50m from the zone	29	250	73	250

Figure 2.1 : Zone 1 Uncapped Saturated Waste (95%ile)

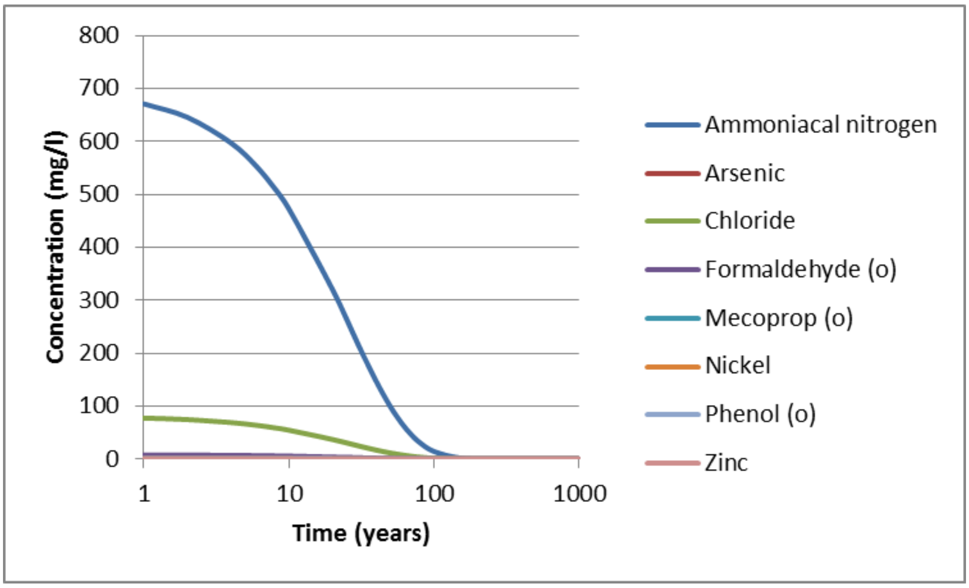
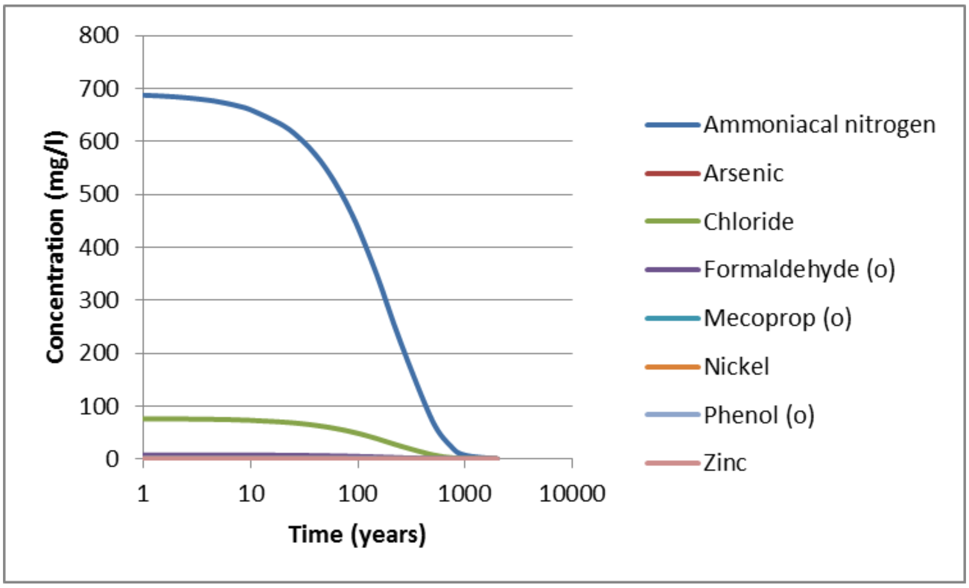


Figure 2.2 : Zone 1 Capped Saturated Waste (95%ile)



It would be expected that the saturated waste concentrations are the same in both capped and uncapped scenarios in the first 20 years (or until such time the wastes are capped), at which point the capping is placed and the concentration decline shapes would diverge. However a review of Figures 2.1 and 2.2 shows that there is a saturated waste source concentration of 200mg/l higher in the capped scenario compared to the uncapped scenario for ammoniacal nitrogen at the 95%ile at the 20 year time point. This is due to the limitation of RAM to simulate a period of open waste followed by a capped waste.

To attempt reducing the significance of this limitation, a sensitivity analysis on ammoniacal nitrogen was undertaken, with a reduced likely source concentration by 100mg/l and a reduced maximum source concentration by 200mg/l in the capped scenario. This resulted in concentrations of ammoniacal nitrogen reasonably matching after 20 years the concentrations at 95%ile for saturated waste in the uncapped scenario. The results of this sensitivity analysis are provided in Table 2.3.

Table 2.3 : Results of sensitivity analysis (Capped Model)

Receptor	Sensitivity Analysis Capped Scenario (50%ile)		Sensitivity Analysis Capped Scenario (95%ile)	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated waste	305	1	511	1
Overburden 10m from the zone	48	250	92	150
Overburden at the Morell River	43	250	85	250
Limestone 50m from the zone	26	250	59	250

A further sensitivity analysis was undertaken to explore the effect of increasing the source terms for chloride and zinc based upon recent ground investigation data which were not available during the initial modelling. The data indicated a potentially higher source concentration within Zone 1 wastes based on the leaching test results from samples collected from Zone 1. The chloride source distribution was therefore increased to range from 0.5mg/l to 500mg/l and the zinc source term was amended to range from 0.013mg/l to 3.7mg/l. The results of this secondary sensitivity analysis is summarised in Table 2.4.

Table 2.4 : Results of sensitivity analysis to assess higher source concentrations (Uncapped Model)

Receptor	Uncapped Scenario (95%ile)		Sensitivity Analysis Uncapped Scenario (95%ile)	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Chloride				
Saturated waste	77	1	376	1
Overburden 10m from the zone	28	20	141	20
Overburden at the Morell River	27	30	137	30
Limestone 50m from the zone	40	10	197	10
Zinc				
Saturated waste	0.06	1	2.8	1
Overburden 10m from the zone	1.91×10^{-4}	2000	0.006	2000
Overburden at the Morell River	1.17×10^{-4}	2000	0.003	2000
Limestone 50m from the zone	3.51×10^{-5}	2000	0.001	2000

Figure 2.3 : Zone 1 Uncapped Overburden Receptor 10m from Zone (95%ile)

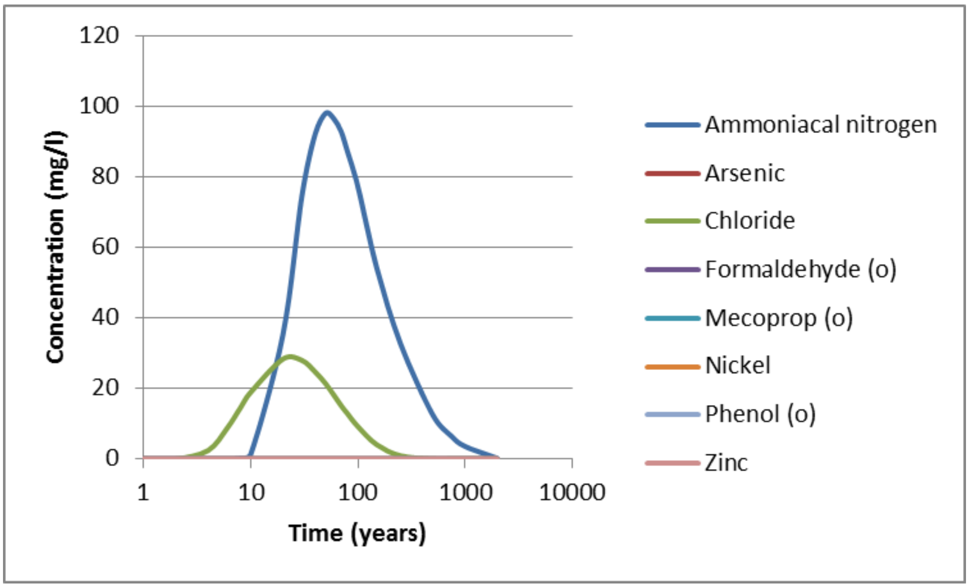


Figure 2.4 : Zone 1 Capped Overburden Receptor 10m from Zone (95%ile)

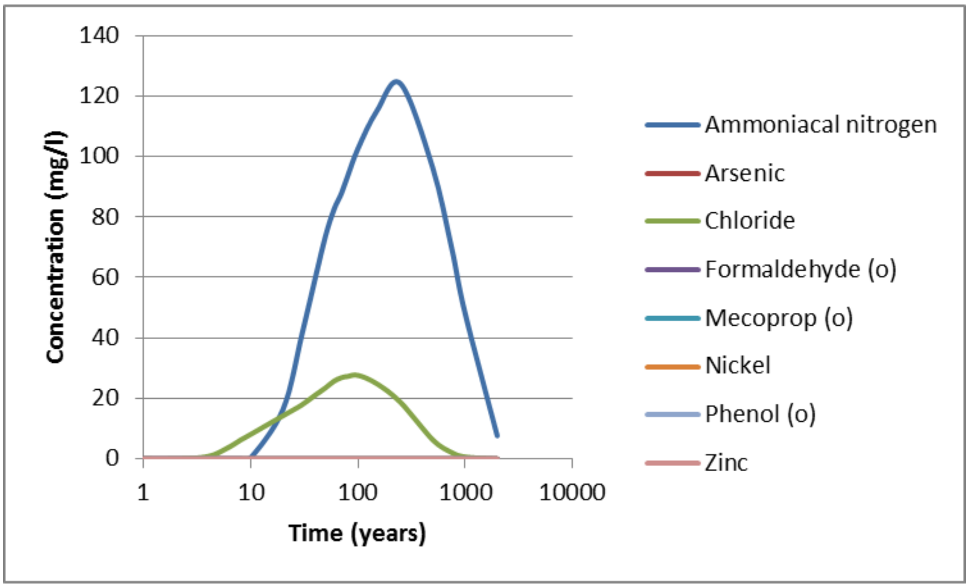


Figure 2.5 : Zone 1 Uncapped Overburden at the River Morell Receptor (95%ile)

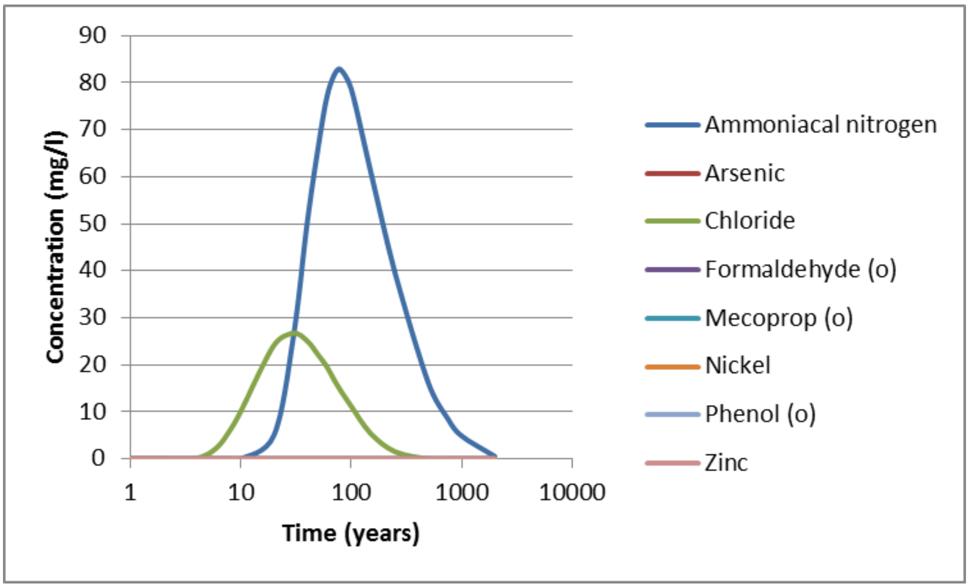


Figure 2.6 : Zone 1 Capped Overburden at the River Morell Receptor (95%ile)

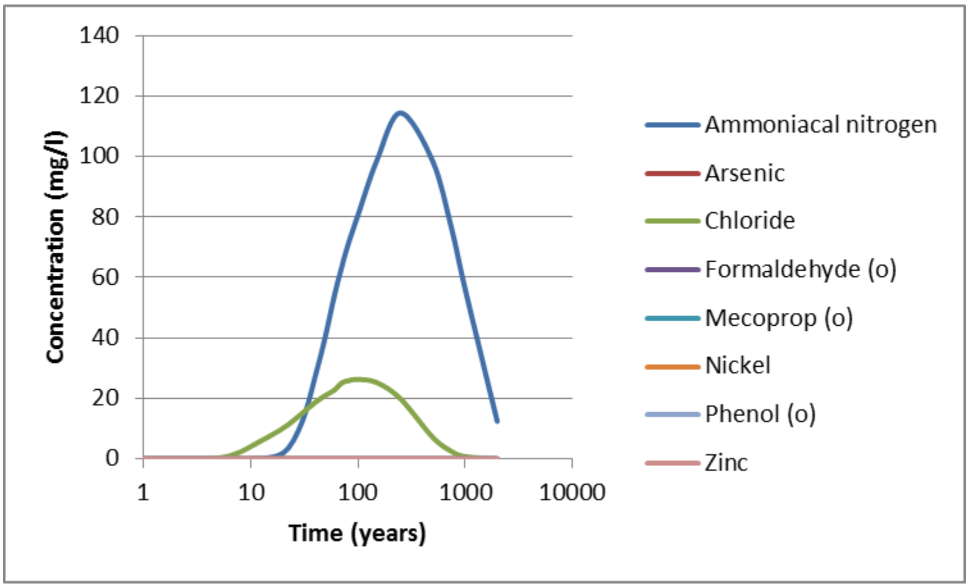


Figure 2.7 : Zone 1 Uncapped Limestone Receptor (95%ile)

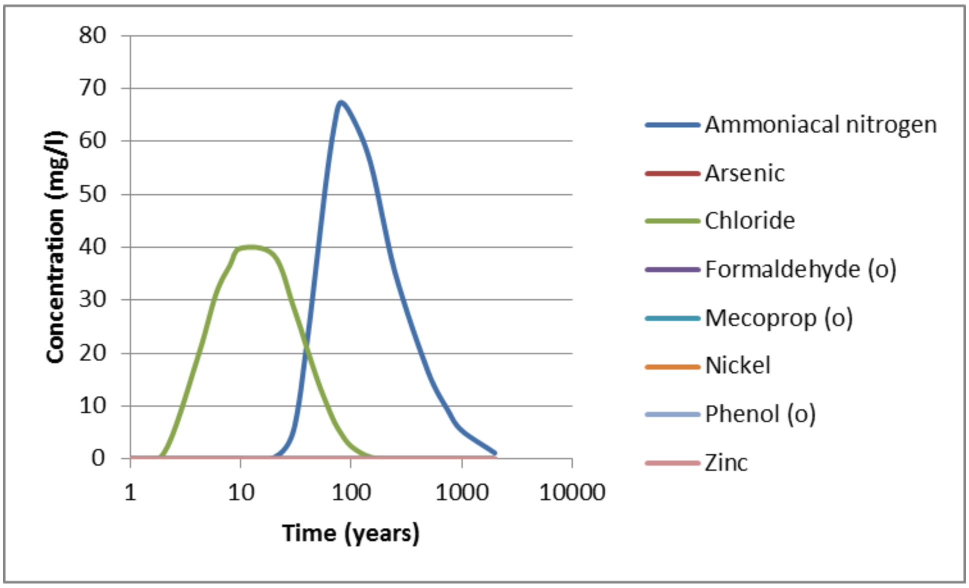
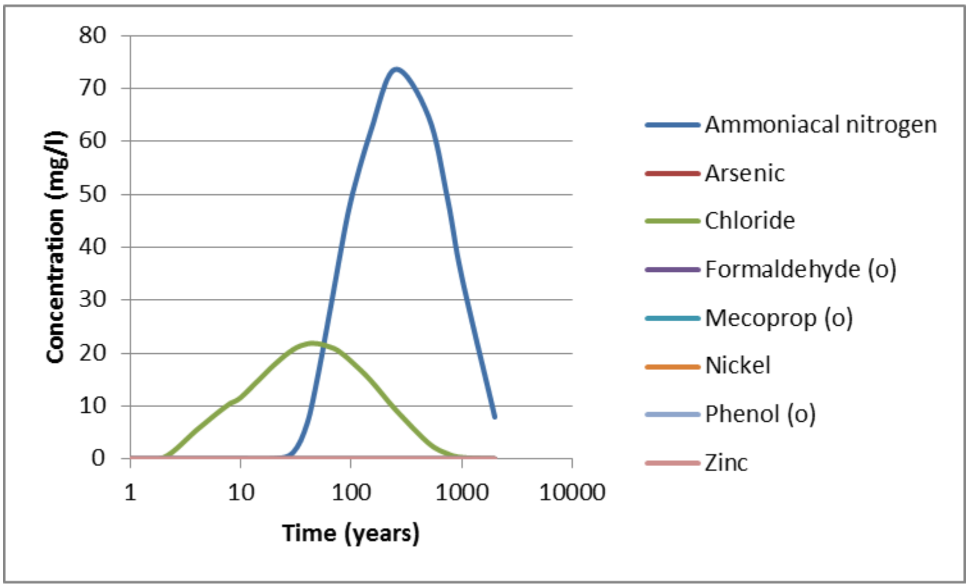


Figure 2.8 : Zone 1 Capped Limestone Receptor (95%ile)



2.3 Interpretation

2.3.1 Assessment of Predicted Concentrations in the Uncapped Model

The uncapped scenario modelling results show the following:

- For ammoniacal nitrogen the peak concentration would occur at around 50 to 100 years at the 10m overburden compliance point. For the point in the aquifer at the Morell River, the peak ammoniacal nitrogen concentration occurs at 80 to 150 years. The model results do largely agree with the concentrations seen for ammoniacal nitrogen in the groundwater beneath and to the east of Zone 1 with concentrations in EMW03 on the zone's eastern boundary being in the order of 10s of mg/l, and up to 93mg/l.

- For chloride, as this substance is not retarded, the peak concentrations are shown to occur slightly earlier at around 20 to 30 years for the 10m point in the overburden deposits and 30 to 40 years at the Morell River. To get concentrations in the model to be the same order of magnitude as measured close to the Morell River, a relatively low source term is required. The sensitivity analysis undertaken with an increased chloride source term produces concentrations in the overburden, 10m beyond the site boundary, of 141mg/l after 20 years, which fits in with the range of concentrations of chloride recorded in groundwater at the site boundary. Concentrations of chloride in groundwater at the site boundary are variable by location, and the value of 28mg/l in the original model agreed well with the majority of recorded chloride groundwater concentrations to the east of the site boundary. This points to the likely variability of the waste in this area in terms of chloride leachability.

- For the metals (arsenic, nickel and zinc), in the 2000 years simulated, the concentrations remain below the IGVs at all off-site receptors, although with concentrations increasing as time progresses. The long times to observe peak impacts for the metals relate to the retardation coefficients with the metals being less mobile than chloride and ammoniacal nitrogen. The concentrations actually measured in the boreholes on the east of the landfill do tend to be higher than the model predicts, even though the modelled source term for nickel and arsenic are relatively elevated based on the abstracted leachate results from Zone 3 and the sensitivity analysis for zinc shows that with a high source term the concentrations still do not exceed the observed concentrations.

- For mecoprop the model shows there would be no impact above the IGV 0f 0.01mg/l on the off-site receptors due to the retardation and degradation of this compound. Low concentrations of mecoprop are recorded in the groundwater to the east of Zone 1 in certain boreholes, with the maximum concentration typically being measured in EMW03 (for example 0.013mg/l in December 2016) with lower concentrations in boreholes closer to the river (for example in EMW05 where mecoprop was not detected in December 2016).

- For formaldehyde, there is no IGV for comparison but the model results do show concentrations remain at a value significantly below the laboratory limit of detection. The groundwater monitoring for formaldehyde does show this compound to generally be absent in boreholes to the east of Zone 1.

- For phenol both the concentrations for capped and uncapped scenarios would be marginally above the IGV 0f 0.0005mg/l at the overburden receptor point 10m from the edge of the landfill for a short period with the peak concentration occurring at around 20 years. Groundwater monitoring does show phenol to be measured in boreholes immediately on the site boundary, but is generally not recorded in boreholes closer to the river.

Overall, this model is believed to be a reasonable representation of the current site conditions for Zone 1, albeit that the metal concentrations recorded in the groundwater are higher than the model predicts.

2.3.2 Comparison of Capped and Uncapped Models

For ammoniacal nitrogen, the capped model predicts greater peak concentrations than the uncapped model at each receptor for the 95%ile (although at the 50%ile the models do predict a lower concentration in the limestone aquifer). As previously discussed, the higher concentrations in the capped model is thought to be due largely to the limitations of the model to simulate the sequence of open waste followed by capping and resulting in source concentrations remaining higher in the first 20 years in the capped model. The sensitivity analysis, with a reduced source term to simulate source concentrations after 20 years matching the uncapped scenario records ammoniacal nitrogen concentrations 15 to 25% lower in overburden and 10 to 20% lower in bedrock than in the original capped model. Overall, there is no clear difference in ammoniacal nitrogen concentrations between the capped and uncapped models. That is believed to be caused that the saturated waste dominating the inflow into the groundwater system.

For chloride, the models show that at the overburden receptors 10m from the landfill and at the Morell River the peak concentrations are broadly similar, although as with ammoniacal nitrogen for the capped model the peak chloride concentration does occur at a later time. For the limestone aquifer, the models do show that the peak chloride concentration for the capped model is around 50% of the predicted concentration in the uncapped model.

For the metals and organic substances, the model results show little difference between the peak concentrations for capped and uncapped models with all peak concentrations at all compliance points in the overburden and limestone being less than 0.004mg/l (4µg/l). The greatest difference is for formaldehyde in the limestone aquifer with the capped model showing a lower concentration than the uncapped model.

2.4 Summary of Zone 1 Model

For Zone 1, the model suggests that the source term is dominated by the saturated waste component, and this is likely to remain the case for this zone such that even after capping, the saturated wastes would continue to have the major input of contaminants to groundwater. The cap will cause the rainfall infiltration which is migrating through the waste to reduce leachate generation and lead to a reduction in the build-up of leachate within the cell and potentially reduce the water levels beneath the landfill (any potential reduction in groundwater level is not included in the RAM model). A reduction in groundwater level beneath the waste, even if this reduction is small, would have benefits to the groundwater environment by:

- Reducing the amount of waste that is saturated and hence reducing the source term;

- Reducing the hydraulic gradient between the site and the Morell River such that the migration of contaminants would be slowed (allowing more time for degradation of organic compounds) and the volume of groundwater discharging to the river would be reduced; and

- Reducing the difference in groundwater levels between the overburden and bedrock water bodies and therefore reducing the flow of groundwater from the overburden deposits to the bedrock transition zone.

In addition, an engineered cap on Zone 1 has the benefit of providing better control for landfill gas and preventing the fugitive emissions of landfill gas and odour and allows surface water runoff to be controlled. It also prevents human contact with the waste materials present within the zone.

3. Zone 2A

3.1 Zone 2A Model Construction

A similar conceptualisation was developed for Zone 2A compared to Zone 1. Waste geometry and travel distances to receptors have been adjusted although for Zone 2A it is assumed that there is no significant waste present below the groundwater table. Chemical characteristics (i.e source terms and Kd values) and overburden hydraulic conductivity estimates have been amended in line with zone specific ground investigation data. The other parameters are the same as those used in the Zone 1 model. As with Zone 1, a capped ("Zone 2A Capped") and uncapped ("Zone 2A Uncapped") model was produced. For the capped scenario infiltration rates have been calculated using the RAM software based on the permeability of the cap and assuming that drains are installed around the entire edge of the zone.

Specific model inputs are provided in Appendix B.

As for Zone 1, it should be noted that a key limitation with RAM is the ability to run the capping scenarios applying an initial phase of open waste infiltration followed by a capped period. The period during which the waste cannot be properly simulated as open waste generates higher source concentrations and a slower decrease in source term in the capped model, which generates a level of conservatism in the capped scenarios that does not apply to the uncapped scenarios. This limitation needs to be taken into account when looking at the factual results obtained with the capped scenarios.

3.2 Model Output

Tables 3.1 and 3.2 summarise the peak values at 50%ile and 95%ile for ammoniacal nitrogen in both the uncapped and capped scenarios with output graphs in Figures 3.1 to 3.6. Results for the other substances are provided in Appendix B.

Results are reported in Tables 3.1 and 3.2 for:

- Overburden 10m from the zone : groundwater concentration within the overburden deposits 10m away from the zone boundary;
- Overburden at the Morell River : groundwater concentration within the overburden deposits adjacent to the Morell River; and
- Limestone: groundwater concentration within the limestone aquifer 50m away from the zone boundary.

Table 3.1 : Uncapped Model Results for Ammoniacal Nitrogen in Zone 2A

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Overburden 10m from the zone	4	40	9	30
Overburden at the Morell River	2	70	5	50
Limestone	0.3	150	2	100

Table 3.2 : Capped Model Results for Ammoniacal Nitrogen in Zone 2A

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Overburden 10m from the zone	1	150	4	100
Overburden at the Morell River	1	150	3	150
Limestone 50m from the zone	0.5	250	2	250

Figure 3.1 : Zone 2A Uncapped Overburden Receptor 10m from Zone (95%ile)

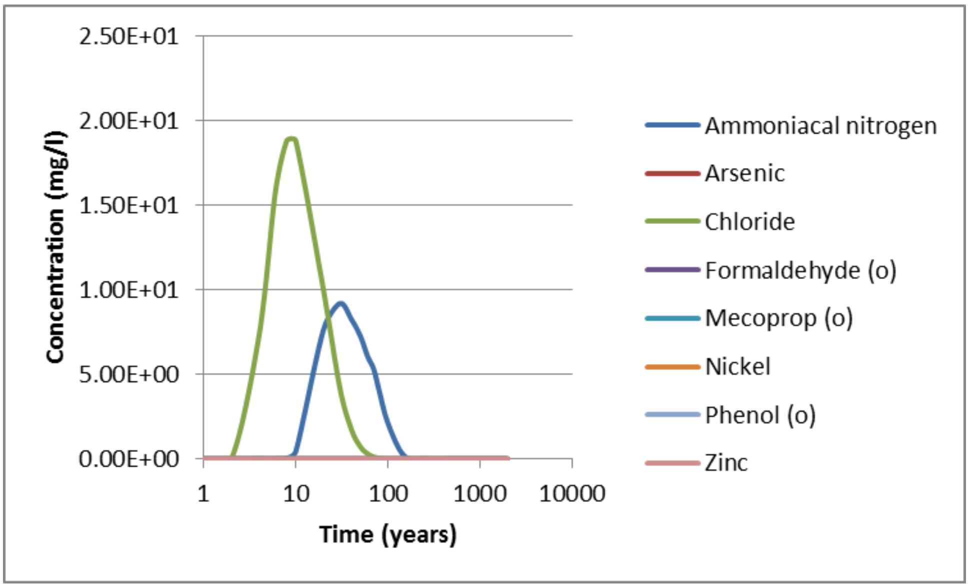


Figure 3.2 : Zone 2A Capped Overburden Receptor 10m from Zone (95%ile)

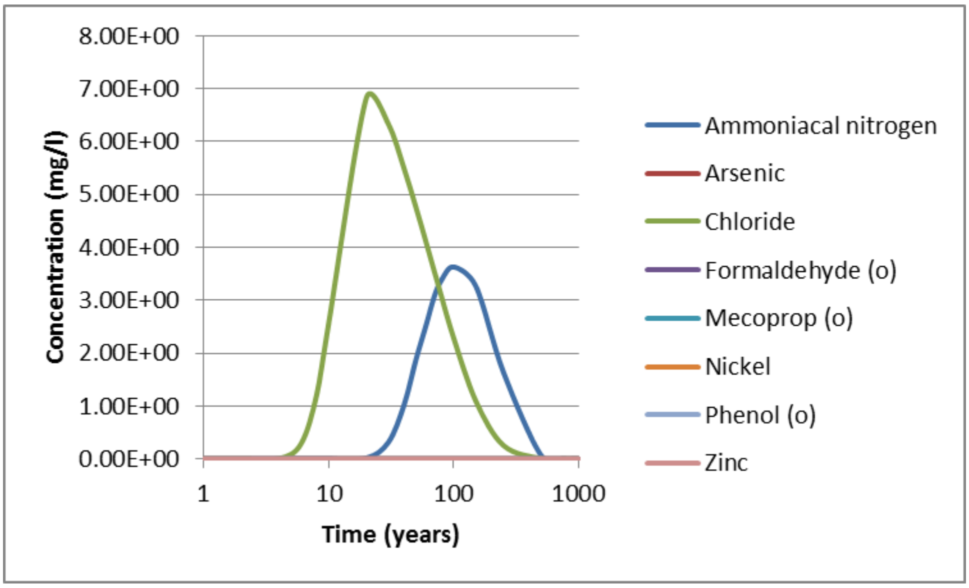


Figure 3.3 : Zone 2A Uncapped Overburden at the River Morell Receptor (95%ile)

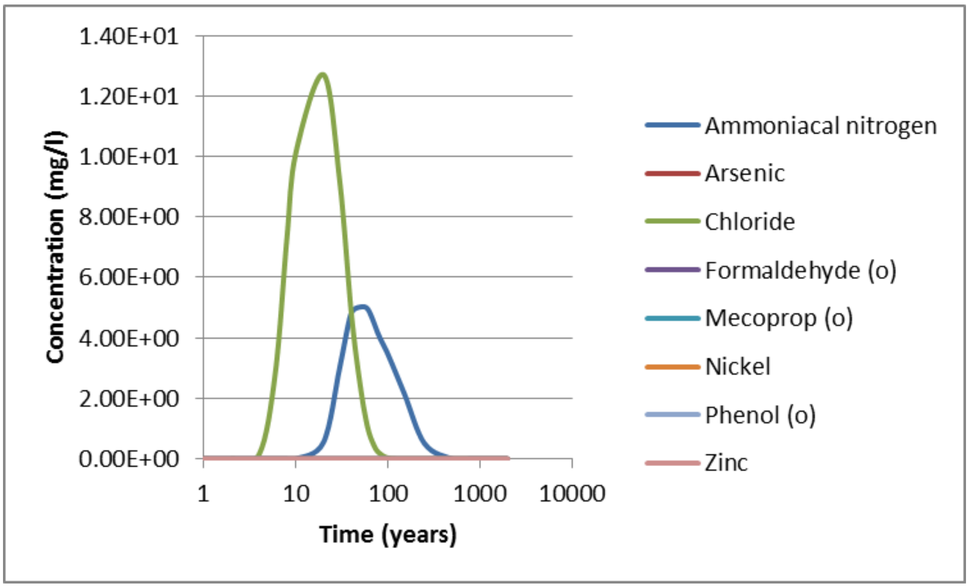


Figure 3.4 : Zone 2A Capped Overburden at the River Morell Receptor (95%ile)

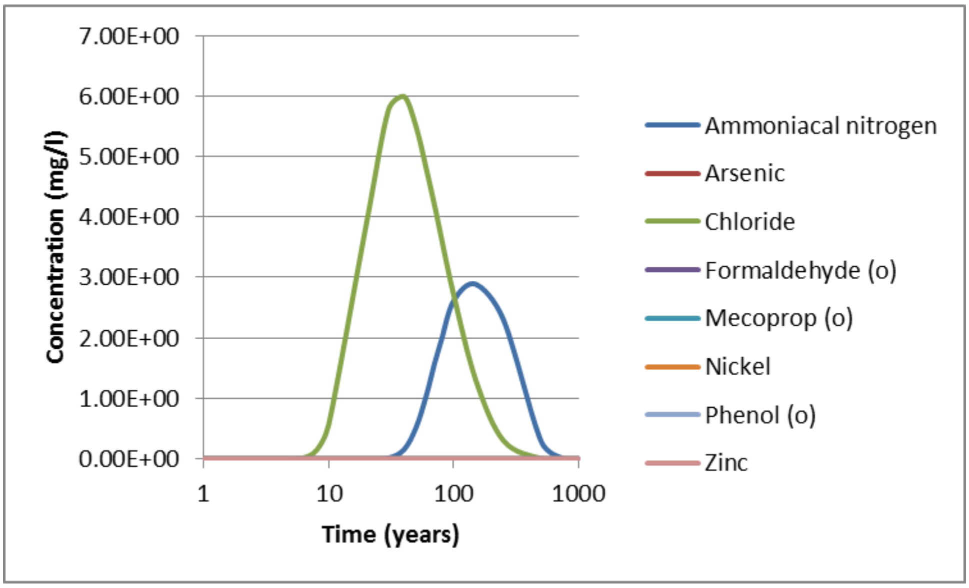


Figure 3.5 : Zone 2A Uncapped Limestone Receptor (95%ile)

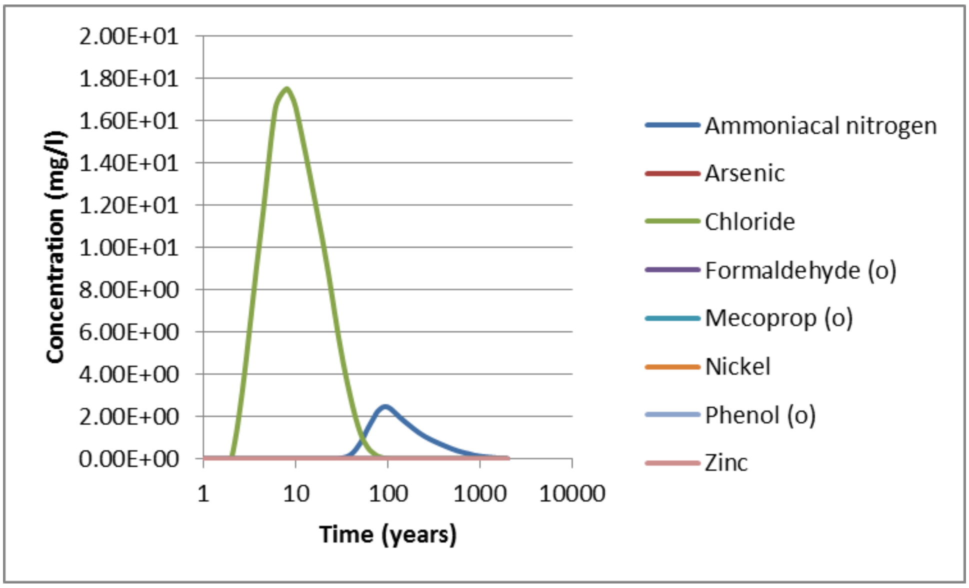
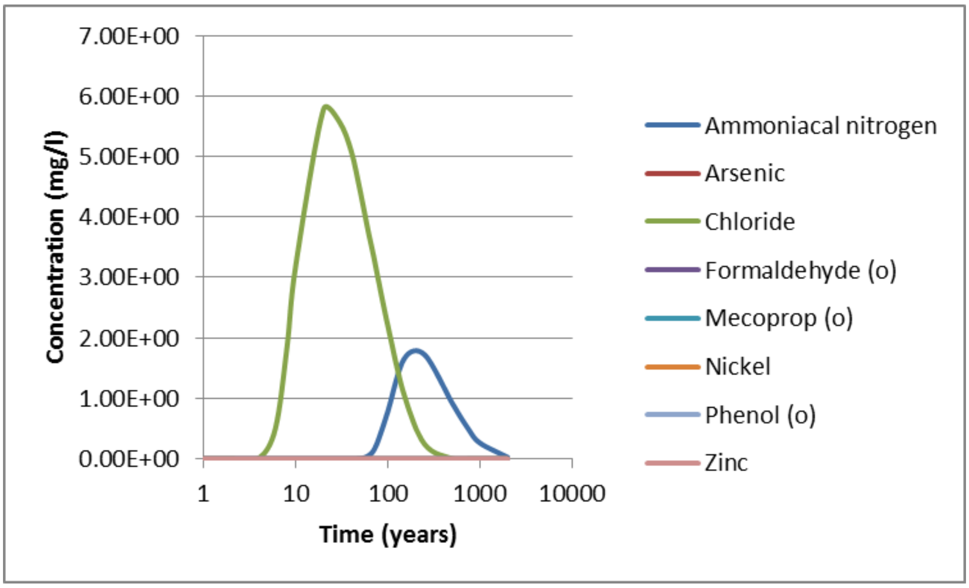


Figure 3.6 : Zone 2A Capped Limestone Receptor (95%ile)



3.3 Interpretation

3.3.1 Assessment of Uncapped Scenario Predicted Concentrations

For Zone 2A there are currently limited monitoring data available for the zone. Borehole EMW11 is situated to the north-west of the zone and this borehole shows relatively low chloride concentrations and ammoniacal nitrogen is recorded as being below the limit of detection. The data do not appear to be representative of wastes identified in Zone 2A as shown on the borehole logs. To the east of the zone (in the direction of the Morell

River) Zone 1 and Zone 2B is present and as such it is not possible to determine the concentrations of substances due solely to Zone 1A.

The uncapped scenario modelling results show the following:

- For ammoniacal nitrogen the peak concentration for the uncapped zone would occur at around 30 to 40 years at the 10m compliance point. For the point in the aquifer at the Morell River, the peak ammoniacal nitrogen concentration occurs at 50 to 70 years.

- For chloride, as this substance is not retarded, the peak concentrations are shown to occur slightly earlier than ammoniacal nitrogen at around 20 years for the 10m point in the overburden aquifer and 40 years at the Morell River.

- For the metals (arsenic, nickel and zinc), the model shows that as with Zone 1, in the 2000 years that are simulated, the concentrations remain below the IGVs at all receptors, although with concentrations increasing as time progresses.

- For mecoprop there would be no impact above the IGV on the receptors due to the retardation and degradation of this compound.

- For formaldehyde there is no IGV for comparison but the model results do show concentrations do remain at a value significantly below the laboratory limit of detection.

- The models do show that for the uncapped scenario the phenol concentration would be above the IGV at the overburden receptor point 10m from the edge of the landfill for a short period with the peak concentration occurring at around 10 years. The concentration of phenol in the capped model does not exceed the IGV at this point or other points in the overburden or limestone aquifers.

3.3.2 Comparison of Capped and Uncapped Models

For all determinands, the capped model predicts lower concentrations at all receptors than the uncapped model with the exception of the 50%ile value in the limestone aquifer which shows a slight increase in the capped model.

The reduction in groundwater concentrations occurs due to the lower recharge through the waste and more dilution in the groundwater flowing beneath the site for the capped model (for this zone it is assumed that input from waste beneath the water table is negligible). In the case of ammoniacal nitrogen and chloride, the predicted peak concentration for the capped scenario for ammoniacal nitrogen and chloride is around 40% of the uncapped concentration. For ammoniacal nitrogen the model predicts that the IGV concentration of 0.15mg/l would be exceeded at all compliance points. As with Zone 1, the peak concentration for the capped model occurs at a later time than the uncapped model.

For the metals and organic substances, the model results show the peak concentrations for the capped scenario to be lower than the uncapped scenario, although in absolute terms the difference is not that great. However, as noted above for phenol the peak concentration for the capped model does not exceed the IGV whereas it does for the uncapped model.

Because of the RAM limitation described earlier, the concentrations generated in the capped model are expected to be higher than the reality and the capped model has conservatism not present in the uncapped model. However, the original source term in Zone 2A is less significant than for Zone 1 and therefore the conservatism introduced for the capped Zone 2A is expected to be more minor than for Zone 1. Overall, this suggests that the capping would provide an overall betterment for Zone 2A.

3.4 Summary of Zone 2A Model

For Zone 2A, the uncapped and capped models do show that there would be an improvement in groundwater quality following installation of the low permeability materials in this zone. This occurs due to lower infiltration into the wastes and subsequent higher dilution of leachate in the groundwater for the capped scenario. As this zone is modelled as having negligible saturated waste, there is no input of leachate from this source as dominates the other zones.

In addition to the predicted improvements to groundwater quality, the emplacement of low permeability materials in Zone 2B has the benefit of providing better control for landfill gas and preventing the fugitive emissions of landfill gas and odour and allows surface water runoff to be controlled. It also prevents human contact with the waste materials present within the zone.

4. Zone 2B

4.1 Zone 2B model construction

A similar conceptualisation was developed for Zone 2B compared to Zone 1. Waste geometry and travel distances to receptors have been adjusted and in the case of Zone 2B it is assumed that for this zone that waste is present beneath the groundwater table throughout the zone. Chemical characteristics (eg source terms and Kd values) and overburden hydraulic conductivity estimates have been amended in line with zone specific ground investigation and monitoring data. The model was calibrated using groundwater quality concentrations recorded immediately downgradient of Zone 2B as well as in vicinity of the Morell River. As with the other zones, a capped (“Zone 2B Capped”) and uncapped (“Zone 2B Uncapped”) model was produced. For the capped scenario infiltration rates have been calculated using the RAM software based on the permeability of the cap and assuming that drains are installed around the entire edge of the zone.

Specific model inputs are provided in Appendix C.

As for Zone 1, it should be noted that a key limitation with RAM is the ability to run the capping scenarios applying an initial phase of open waste infiltration followed by a capped period. The period during which the waste cannot be properly simulated as open waste generates higher source concentrations and a slower decrease in source term, which generates a level of conservatism in the capped scenarios that does not apply to the uncapped scenarios. This limitation needs to be taken into account when looking at the factual results obtained with the capped scenarios.

4.2 Model output

Table 4.1 and Table 4.2 summarise the peak values at 50%ile and 95%ile for ammoniacal nitrogen in both the uncapped and capped scenarios with output graphs in Figures 4.1 to 4.8. Results for the other substances are provided in Appendix C.

Table 4.1 : Uncapped Model Results for Ammoniacal Nitrogen in Zone 2B

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated Waste	45	1	76	1
Overburden 10m from the zone	4	40	9	30
Overburden at the Morell River	3	50	7	30
Limestone	0.6	150	3	60

Table 4.2 : Capped Model Results for Ammoniacal Nitrogen in Zone 2B

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated Waste	46	1	76	1
Overburden 10m from the zone	3	60	7	70
Overburden at the	3	80	6	70

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Morell River				
Limestone 50m from the zone	0.8	150	3	100

Figure 4.1 : Zone 2B Uncapped Saturated Waste (95%ile)

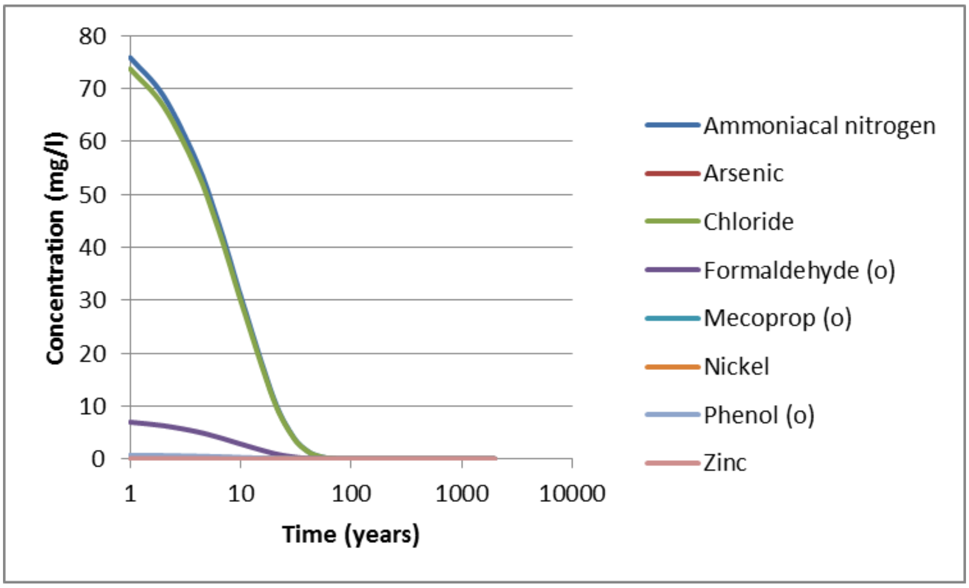


Figure 4.2 : Zone 2B Capped Saturated Waste (95%ile)

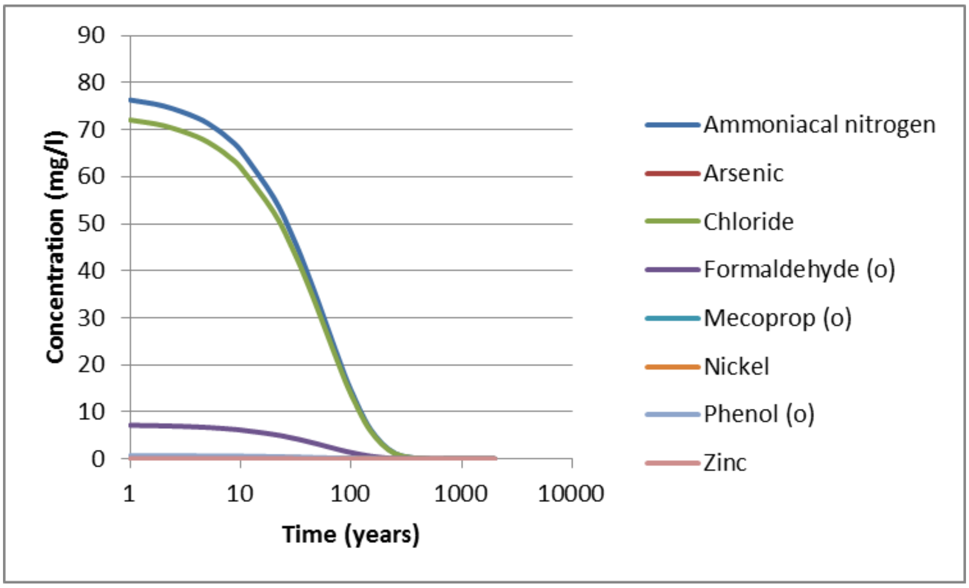


Figure 4.3 : Zone 2B Uncapped Overburden Receptor 10m from Zone (95%ile)

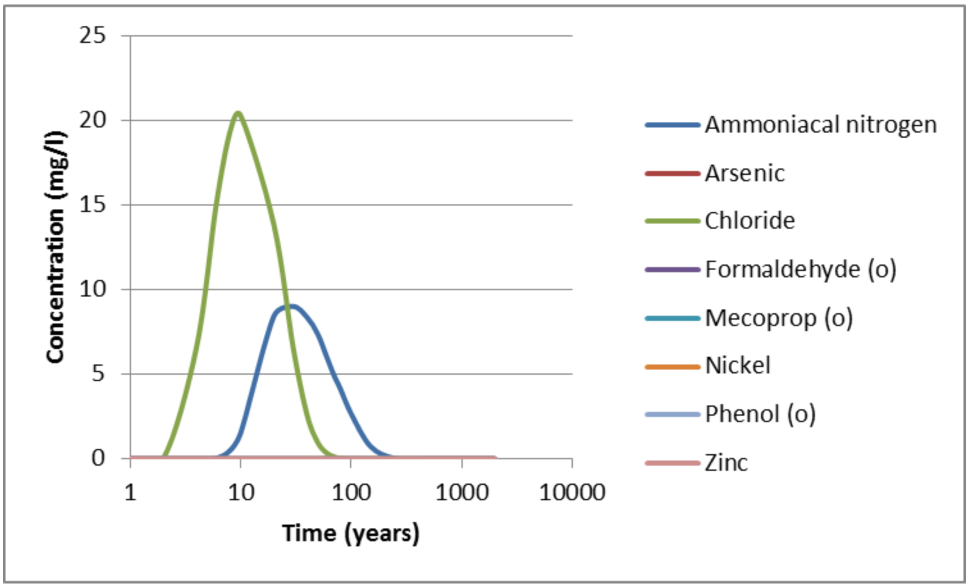


Figure 4.4 : Zone 2B Capped Overburden Receptor 10m from Zone (95%ile)

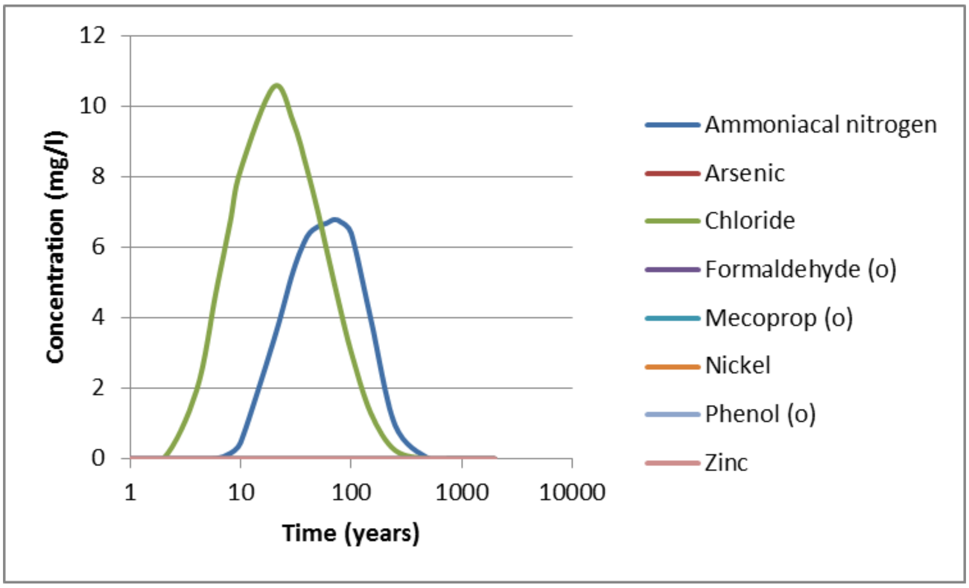


Figure 4.5 : Zone 2B Uncapped Overburden at the River Morell Receptor (95%ile)

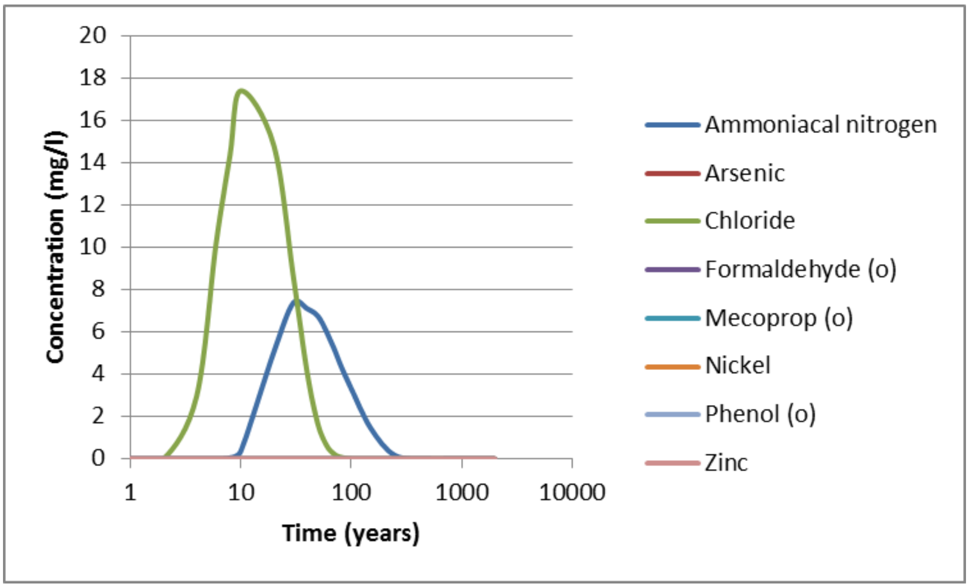


Figure 4.6 : Zone 2B Capped Overburden at the River Morell Receptor (95%ile)

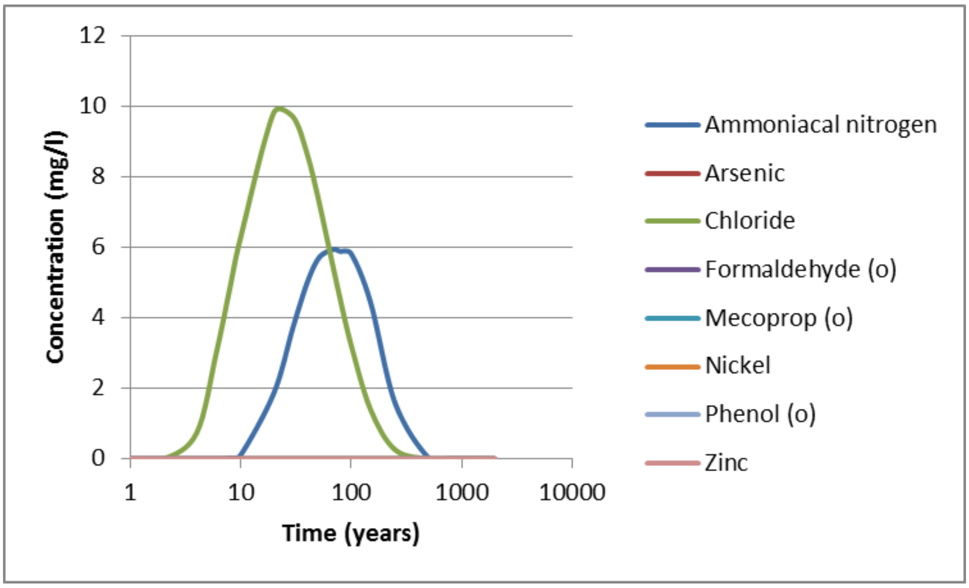


Figure 4.7 : Zone 2B Uncapped Limestone Receptor (95%ile)

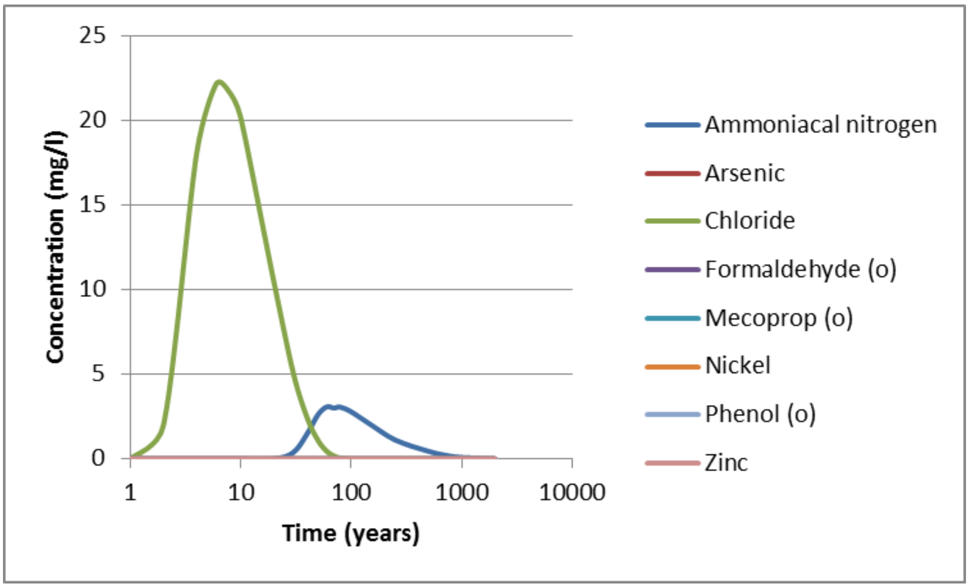
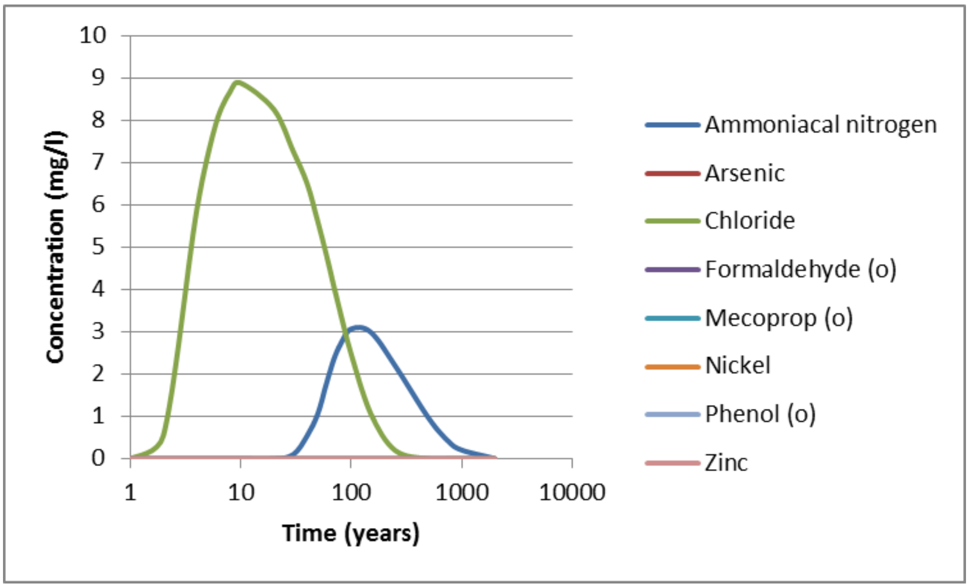


Figure 4.8 : Zone 2B Capped Limestone Receptor (95%ile)



4.3 Interpretation

4.3.1 Assessment of Uncapped Scenario Predicted Concentrations

The uncapped scenario modelling results show the following:

- for ammoniacal nitrogen the peak concentration for the uncapped zone would occur at around 30 to 40 years at the 10m compliance point. For the point in the aquifer at the Morell River, the peak ammoniacal nitrogen concentration occurs at 30 to 50 years. With respect to the observed concentrations in the groundwater, the model results do largely agree with the concentrations seen for ammoniacal nitrogen in the groundwater beneath and to the east of Zone 2B with concentrations in EMW07 and EMW19 on the zone's eastern boundary being in the order of 5 mg/l. In both the model case and the actual monitoring results, ammoniacal nitrogen concentrations do exceed the IGV of 0.15mg/l.

- For chloride, as this substance is not retarded, the peak concentrations are shown to occur slightly earlier at around 20 years for the 10m point in the overburden aquifer and at the Morell River. For chloride, to get concentrations in the model to be the same order of magnitude as measured in groundwater between the zone and the Morell River in EMW08 a relatively low source concentration is required such that the chloride model results at the overburden 10m assessment point (20mg/l at the 95%ile) are lower than measured in borehole EMW07 and EMW19 (these being 31mg/l and 27mg/l respectively in December 2016).

- For the metals (arsenic, nickel and zinc), as with other zones the model shows that in the 2000 years that are simulated, the concentrations remain below the IGVs at all off-site receptors, although with concentrations increasing as time progresses.

- For mecoprop there would be no impact above the IGV on the receptors due to the retardation and degradation of this compound.

- For formaldehyde there is no IGV for comparison but the model results do show concentrations do remain at a value significantly below the laboratory limit of detection.

- The uncapped model shows that for phenol the concentration would be above the IGV at the overburden receptor point 10m from the edge of the landfill for a short period with the peak concentration occurring at around 10 years. This is also the case for the capped scenario.

4.3.2 Comparison of capped and uncapped models

For the majority of determinands and assessment points, the capped model predicts lower concentrations than the uncapped model (the 50%ile for impact on limestone does show the capped scenario to have slightly greater impact). In the case of ammoniacal nitrogen the predicted peak concentration for the capped scenario is around 75% of the uncapped concentration and for chloride the value is around 50%. For ammoniacal nitrogen the model predicts that the IGV concentration of 0.15mg/l would be exceeded at all compliance points. As with the other zones, the peak concentration for the capped model occurs at a later time than the uncapped.

For the metals and organic substances, the model results show that for the majority of the substances the peak concentrations for the capped scenario to be lower than the uncapped scenario, although in absolute terms the difference is not significant. However, as noted above for phenol the peak concentration for both the capped and uncapped model does exceed the IGV although the peak concentration for the capped model is around 30% lower than for the uncapped model.

Because of the RAM limitation described earlier, the concentrations generated in the capped model are expected to be higher than the reality and the capped model has conservatism not present in the uncapped model. However, the original source term in Zone 2B is less significant than for Zone 1 and therefore the conservatism introduced for the capped Zone 2B is expected to be more minor than for Zone 1. Overall, this suggests that the capping would provide an overall betterment for Zone 2B.

4.4 Summary of Zone 2B Model

For Zone 2B, the uncapped and capped models do show that there would be an improvement in groundwater quality following installation of the low permeability materials in this zone. This occurs due to lower infiltration into the wastes and subsequent higher dilution of leachate in the groundwater for the capped scenario. However, as the saturated waste provides the input component for this zone and the wastes are likely to remain saturated after the zone is capped, the predicted improvement in groundwater quality is not that great.

In addition to the predicted improvements to groundwater quality, the emplacement of low permeability materials in Zone 2B has the benefit of providing better control for landfill gas and preventing the fugitive emissions of landfill gas and odour and allows surface water runoff to be controlled. It also prevents human contact with the waste materials present within the zone.

5. Zone 3

5.1 Zone 3 model construction

Four LandSim models have been produced; two to represent the current site conditions and two to represent the site conditions following the filling of the lined cell and installation of an engineered cap. For each capped and uncapped scenario, two models were produced as follows:

- One model called “overburden pathway” to determine risks to the overburden groundwater quality, in particular in vicinity of the Morell River; and
- A second model called “bedrock pathway” to determine risks to the bedrock aquifer.

Model inputs are provided in Appendix D. It should be noted that the capped model represents an enlarged waste area (as wastes are removed from other zones and placed into Zone 3).

For the current site condition models, the source concentrations are based on recorded leachate concentrations from Zone 3, leachability tests and literature values. For the capped and fully landfilled scenario, the source concentrations were altered to reflect the source characteristics of waste moved from other zones at the site, using the predicted source outputs from the Zone 1 RAM model after 10 years.

5.2 Model output

Table 5.1 summarises the peak values at 50%ile and 95%ile for the contaminants of concern modelled in Zone 3 up to 1000 years and compares them against the IGV criteria. Any contaminant concentration beyond 1000 years is considered of low significance from the point of view site management and legacy. It should be noted that the concentrations for hazardous substances are taken prior to entry into the groundwater body considered as receptor, and non-hazardous substances are taken within the receptor groundwater body at its point of compliance. These point of compliance for non-hazardous substances are considered to be the overburden groundwater adjacent to the River Morell and the bedrock groundwater immediately downgradient of Zone 3. It should be noted that for Zone 3, all other determinands included in the LandSim model (arsenic, benzene, cadmium, formaldehyde, mecoprop, mercury, nickel, phenol and zinc) did not show any breakthrough at the compliance points in the 1000 years that was simulated.

Table 5.1 : Predicted Concentrations at Relevant Compliance Points

LandSim Model	Time to peak impact (years^)		Peak Concentration (mg/l)		Criteria Comparison	
	50%ile	95%ile	50%ile	95%ile	IGV (mg/l)	Exceedance Y/N?
Ammoniacal Nitrogen						
Current Model (Bedrock Pathway)	N/A	1000	ND	2.6x10-8	0.15	No
Current Model (Overburden Pathway)	1000	1000	9x10-5	0.022	0.15	No
Capped Model (Bedrock Pathway)	N/A	1000	ND	1.5x10-7	0.15	No
Capped Model (Overburden Pathway)	1000	1000	7.4x10-5	0.034	0.15	No

LandSim Model	Time to peak impact (years^)		Peak Concentration (mg/l)		Criteria Comparison	
	50%ile	95%ile	50%ile	95%ile	IGV (mg/l)	Exceedance Y/N?
Chloride						
Current Model (Bedrock Pathway)	1000	1000	0.0007	0.013	30	No
Current Model (Overburden Pathway)	370	530	0.24	0.4	30	No
Capped Model (Bedrock Pathway)	1000	1000	0.0013	0.042	30	No
Capped Model (Overburden Pathway)	1000	740	0.75	1.0	30	No

Note: arsenic, benzene, cadmium, formaldehyde, mecoprop, mercury, nickel, phenol and zinc were also modelled but showed no breakthrough and are therefore not included in the table

5.3 Interpretation

Table 5.1 shows that the scenarios simulated result in concentrations below IGVs. As a consequence, the restoration of Zone 3, with the addition of waste redistributed from other site zones is not expected to generate any additional contamination to the bedrock aquifer nor groundwater in the overburden deposits in close proximity to the Morell River.

Whilst the capped model does show slightly greater concentrations than the uncapped model for ammoniacal nitrogen and chloride, this occurs principally due to the larger area of waste being present in the capped scenario due to the importation of materials from other zones on the site and the concentrations remain below IGV. This is therefore expected to have no impact on water receptors.

A drainage failure scenario was simulated with an increased leachate head of 1m, and exceedances were only recorded for ammoniacal nitrogen after 800 years. The drainage failure scenario was simulated to reflect on temporary failures of the drainage system, and this sensitivity analysis shows that only a continuous and long term drainage failure would be a cause for concern for the site.

5.4 Summary of Zone 3 Model

Due to the capped model having a larger area than the uncapped model, the capped scenario is shown to generate slightly higher concentrations of ammoniacal nitrogen and chloride in the groundwater than the uncapped scenario. However, in both cases the predicted impacts result in concentrations below the IGVs and have therefore no impact on the water receptors.

It should also be considered that by transferring waste materials from other parts of the site to Zone 3, the risks in those other areas is reduced and placing the materials in a fully engineered landfill cell would provide overall betterment for the site.

6. Zone 4

6.1 Zone 4 model construction

A similar conceptualisation was developed for Zone 4 compared to Zone 1. However, waste geometry and travel distances to receptors have been adjusted. For Zone 4 it is assumed that there is both saturated and unsaturated waste and that the saturated waste is an area to the north of the zone. Chemical characteristics (eg source terms and Kd values) and overburden hydraulic conductivity estimates have been amended in line with zone specific ground investigation and monitoring data. The model was calibrated using groundwater quality concentrations recorded immediately downgradient of Zone 4. As with the other zones, a capped ("Zone 4 Capped") and uncapped ("Zone 4 Uncapped") model was produced. For the capped scenario infiltration rates have been calculated using the RAM software based on the permeability of the cap and assuming that drains are installed around the entire edge of the zone.

Specific model inputs are provided in Appendix E.

As for Zone 1, it should be noted that a key limitation with RAM is the ability to run the capping scenarios applying an initial phase of open waste infiltration followed by a capped period. The period during which the waste cannot be properly simulated as open waste generates higher source concentrations and a slower decrease in source term, which generates a level of conservatism in the capped scenarios that does not apply to the uncapped scenarios. This limitation needs to be taken into account when looking at the factual results obtained with the capped scenarios.

6.2 Model output

Table 6.1 and Table 6.2 summarise the peak values at 50%ile and 95%ile for ammoniacal nitrogen in both the uncapped and capped scenarios. Results for the other substances are provided in Appendix E.

Table 6.1 : Uncapped Model Results for Ammoniacal Nitrogen in Zone 4

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated Waste	5	1	8	1
Overburden 10m from the zone	0.6	20	1.1	20
Overburden at the Morell River	0.6	20	1.1	20
Limestone	0.07	150	0.3	80

Table 6.2 : Capped Model Results for Ammoniacal Nitrogen in Zone 4

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Saturated Waste	5	1	8	1
Overburden 10m from the zone	0.2	20	0.6	30
Overburden at the Morell River	0.2	30	0.6	40

Receptor	50%ile		95%ile	
	Peak Concentration (mg/l)	Time to Peak (years)	Peak Concentration (mg/l)	Time to Peak (years)
Limestone 50m from the zone	0.08	250	0.2	150

Figure 6.1 : Zone 4 Uncapped Saturated Waste (95%ile)

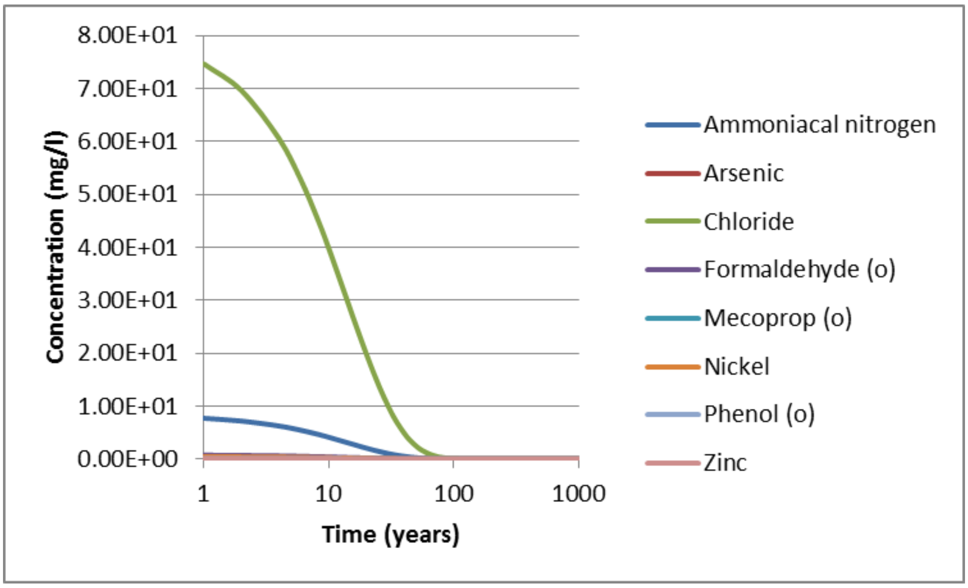


Figure 6.2 : Zone 4 Capped Saturated Waste (95%ile)

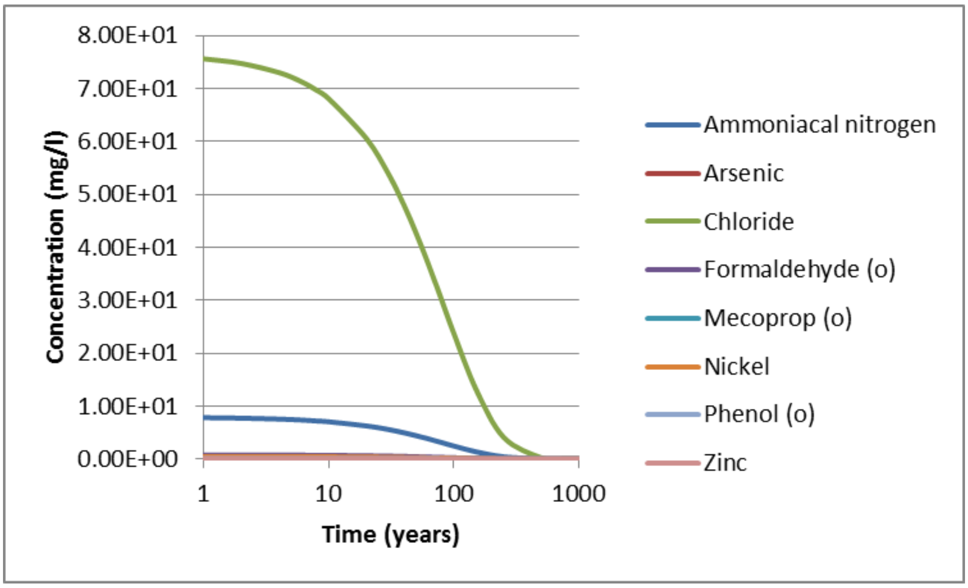


Figure 6.3 : Zone 4 Uncapped Overburden Receptor 10m from Zone (95%ile)

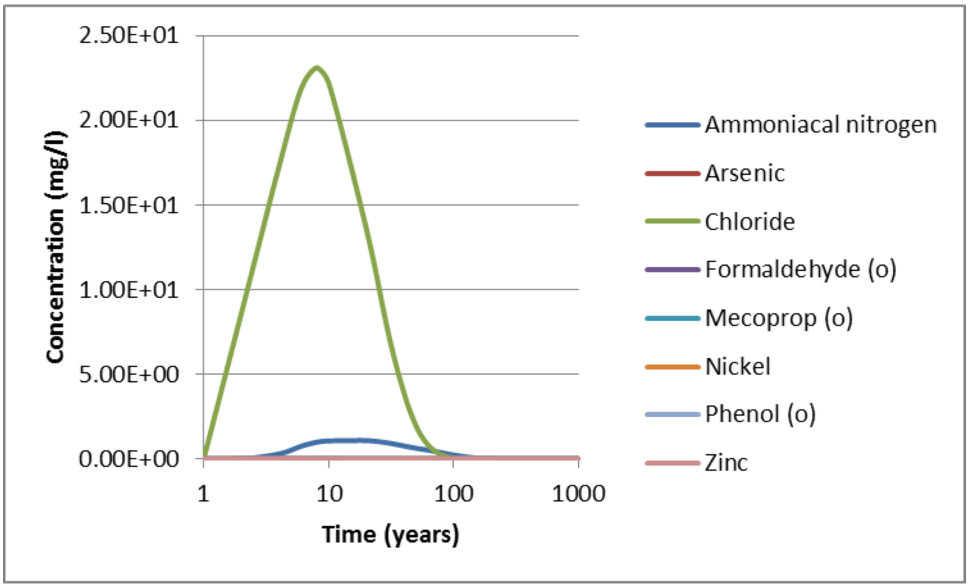


Figure 6.4 : Zone 4 Capped Overburden Receptor 10m from Zone (95%ile)

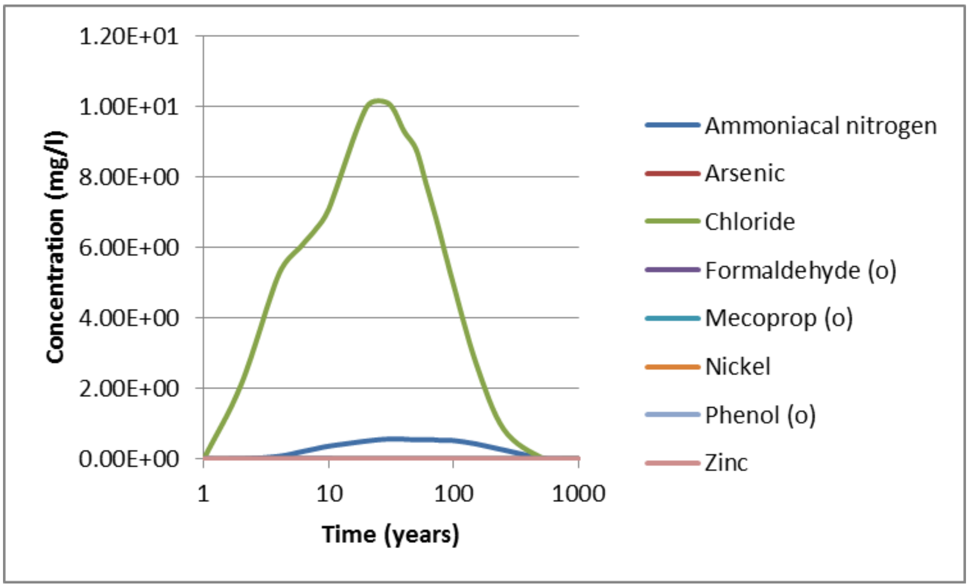


Figure 6.5 : Zone 4 Uncapped Overburden at the River Morell Receptor (95%ile)

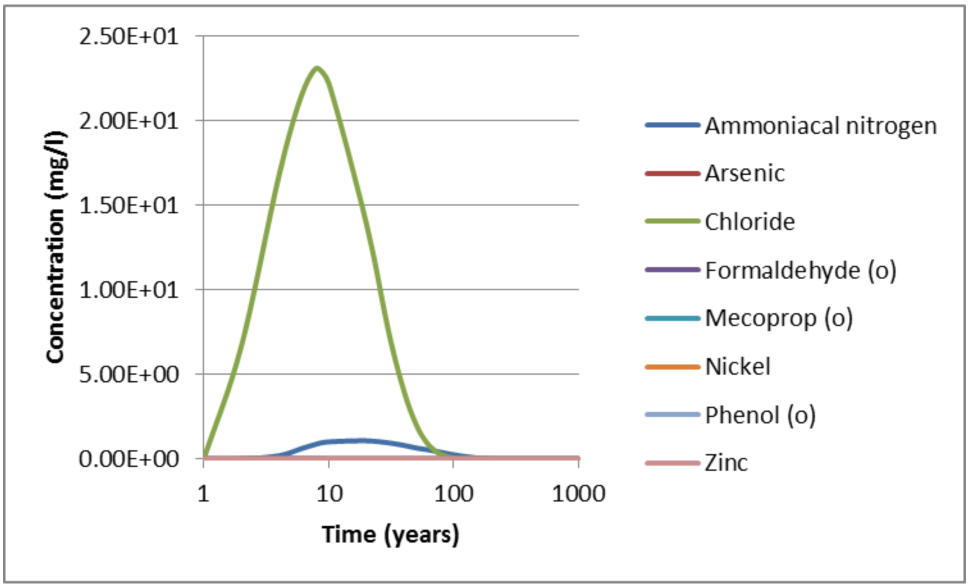


Figure 6.6 : Zone 4 Capped Overburden at the River Morell Receptor (95%ile)

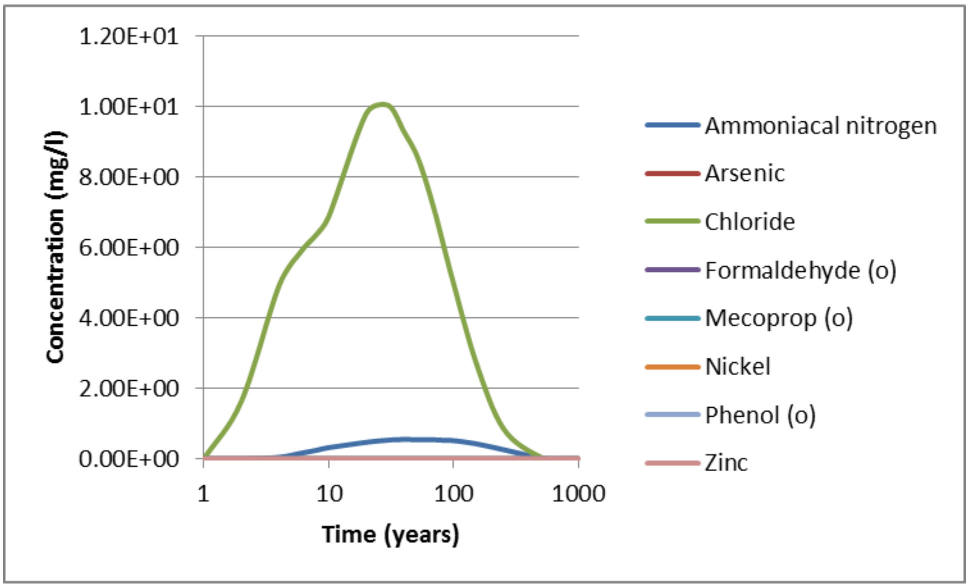


Figure 6.7 : Zone 4 Uncapped Limestone Receptor (95%ile)

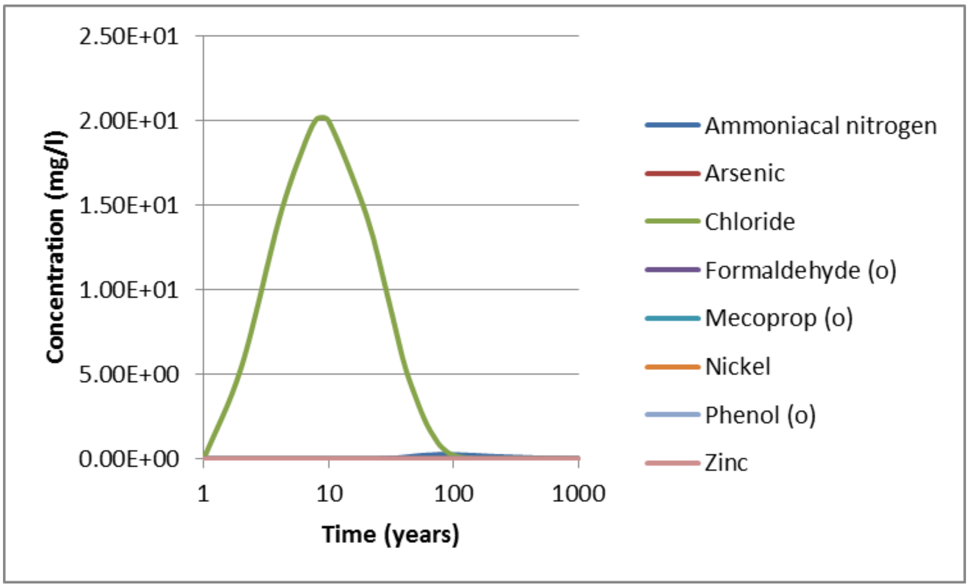
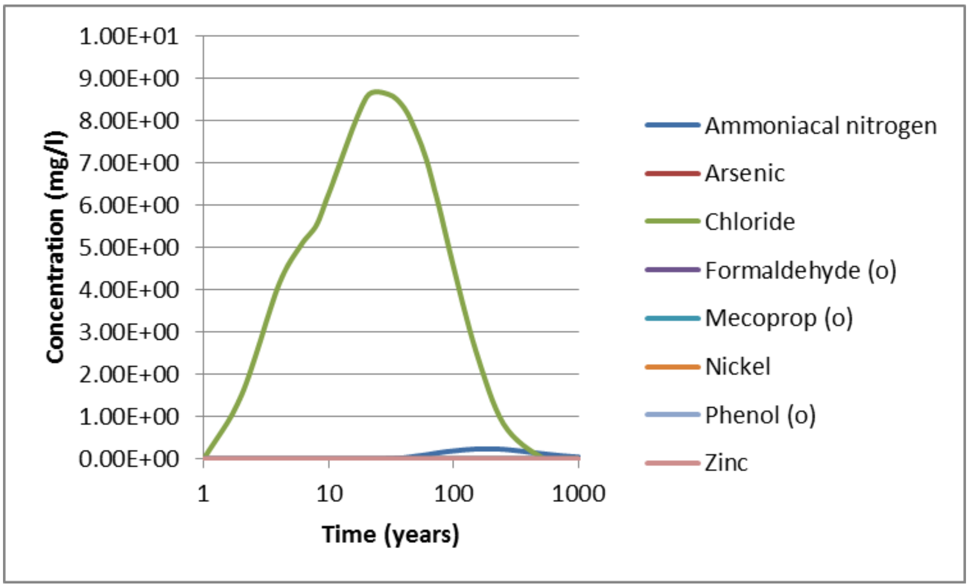


Figure 6.8 : Zone 4 Capped Limestone Receptor (95%ile)



6.3 Interpretation

6.3.1 Assessment of Predicted Concentrations

The uncapped scenario modelling results show the following:

- For ammoniacal nitrogen, the peak concentration for the uncapped zone would occur at around 20 years at the 10m compliance point. For the point in the aquifer at the Morell River, the peak ammoniacal nitrogen concentration would also occur at around 20 years due to the relatively short distance from the zone's eastern boundary to the Morell River. The model results do largely agree with the concentrations seen for ammoniacal nitrogen in the groundwater beneath and to the east of Zone 4 with concentrations in EMW18 on the zone's eastern boundary generally being below 1 mg/l and concentrations in EMW17 typically being between 1mg/l and 2mg/l. Both actual and model results exceed the IGV for ammoniacal nitrogen of 0.15mg/l.

- For chloride, as this substance is not retarded, the peak concentrations are shown to occur slightly earlier at around 8 years for the 10m point in the overburden aquifer and at the Morell River. For chloride, the uncapped model largely agrees with the concentration in EMW18 (model results of 23mg/l at the 95%ile compared to monitoring results in the order of 20mg/l) but there are no boreholes further from the site towards the Morell River to allow further assessment.

- For the metals (arsenic, nickel and zinc), as with other zones the model shows that in the 2000 years that are simulated, the concentrations remain below the IGVs at all off-site receptors, although with concentrations increasing as time progresses.

- For mecoprop and phenol there would be no impact above the IGV on the receptors due to the retardation and degradation of these compounds. In the December 2016 monitoring round the concentrations of mecoprop and phenol were below the limit of detection.

- For formaldehyde there is no IGV for comparison but the model results do show concentrations do remain at a value significantly below the laboratory limit of detection.

6.3.2 Comparison of capped and uncapped models

For the majority of determinands and assessment points, the capped model predicts lower concentrations than the uncapped model. In the case of ammoniacal nitrogen the predicted peak concentration for the capped scenario is around 35% of the uncapped concentration and for chloride the value is around 35%. As with the other zones, the peak concentration for the capped model occurs at a later time than the uncapped.

For the organic substances, the model results show that the peak concentrations for the capped scenario to be lower than the uncapped scenario, although in absolute terms the difference is limited. For the metals, the capped model does show the peak concentrations to be marginally higher than for the uncapped model, although in all cases the difference in peak concentration is less than 0.001 mg/l (1 μg/l).

Because of the RAM limitation described earlier, the concentrations generated in the capped model are expected to be higher than the reality and the capped model has conservatism not present in the uncapped model. However, the original source term in Zone 4 is less significant than for Zone 1 and therefore the conservatism introduced for the capped Zone 4 is expected to be more minor than for Zone 1. Overall, this suggests that the capping would provide an overall betterment for Zone 4.

6.4 Summary of Zone 4 Model

For Zone 4, the uncapped and capped models do show that there would be an improvement in groundwater quality following installation of the low permeability materials in this zone. This occurs due to lower infiltration into the wastes and subsequent higher dilution of leachate in the groundwater for the capped scenario. However, as the saturated waste provides the major input component for this zone, and the wastes are likely to remain saturated after the zone is capped, the predicted improvement in groundwater quality is limited.

In addition to the predicted improvements to groundwater quality, the emplacement of low permeability materials in Zone 4 has the benefit of preventing human contact with the waste materials present within the zone.

7. Summary

The DQRA undertaken for the five zones has shown that the proposed remediation works would improve groundwater quality in the majority of the zones although for Zone 1 and Zone 3 the model do not predict an improvement on groundwater quality for the capped scenarios.

For Zone 1, the higher concentrations in the capped model is thought to be due to the limitations of the model to simulate the sequence of open waste followed by capping and resulting in source concentrations remaining higher in the first 20 years in the capped model combined with a high concentration source term and a significant proportion of saturated waste. In Zone 3, it is proposed that the capped landfill would take waste materials from other zones, resulting in a larger area containing waste compared to the current uncapped scenario. However, it should be borne in mind that by taking wastes from other zones which are currently not contained in a fully engineered landfill would reduce the risks in these other zones for the betterment of the site as a whole.

The modelling does show that where wastes are present beneath the groundwater table it is this saturated waste that provides the dominant source of contaminants to the groundwater system. Capping of the site is unlikely to reduce groundwater levels to the extent that wastes are no longer saturated and these wastes would provide an on-going contaminant source. These saturated wastes are likely to provide a source of contamination over a shorter time period than the unsaturated wastes as groundwater flowing through the saturated wastes is likely to deplete the source quicker than the infiltration through the unsaturated waste. Whilst the contaminant mass in the unsaturated zone would eventually leach/seep downwards and act as a constantly replenishing source, with the cap the rate of this movement to the groundwater is reduced.

It should be noted that the cap may lead to a reduction in groundwater levels, particularly beneath Zone 1, and this could have benefit by:

- Marginally reducing the amount of waste that is saturated and hence reducing this aspect of the source term;
- Reducing the hydraulic gradient between the site and the Morell River such that the migration of contaminants would be slowed (allowing more time for degradation of organic compounds) and the volume of groundwater discharging to the river would be reduced; and
- Reducing the difference in groundwater levels between the overburden and bedrock water bodies and therefore reducing the flow of groundwater from the overburden deposits to the bedrock transition zone.

Whilst the modelling of capping of the site to reduce infiltration does not predict a vast improvement in groundwater quality, the proposed remediation works have benefits outside of the groundwater improvements including.

- Providing better control for landfill gas and preventing the fugitive emissions of landfill gas and odour.
- Allowing surface water runoff to be collected and controlled.
- Preventing human contact with the waste materials present within the site.

These overall improvements allow for the site to be redeveloped for a beneficial community use.

8. References

1. Jacobs, 2017. Kerdiffstown Landfill Remediation Project. Groundwater and Surface Water Monitoring Report - December 2016.

2. IGSL, 2017. Factual Report of 2016 Ground Investigation (in preparation).

3. Jacobs, 2017. Kerdiffstown Landfill Remediation Project. Environmental Impact Assessment Report (EIAR) - Chapter 13 Soils, Geology, Hydrogeology and Contaminated Land (in preparation).

4. Jacobs, 2016. Kerdiffstown Landfill. Preliminary CSMs Technical Note.

5. Environment Agency, 2003. The Development of LandSim 2.5.

6. ESI Limited, 2008. Guide to Using RAM3 Risk Assessment Model.

7. Jacobs, 2014. Kerdiffstown Landfill Remediation Project. Groundwater DQRA Report.

8. Environmental Protection Agency (undated). Towards Setting Guideline Values for the Protection of Groundwater in Ireland. Interim Report.

Appendix A. Zone 1 input parameters and results

MODEL INPUTS

LANDFILL WASTE:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Distribution		triangular	triangular	triangular	triangular	triangular	triangular	triangular	triangular
Landfill waste leaching test concentration Minimum	mg/L	88	0.0025	0.47	0.0001	0.001	0.003	0.001	0.0025
Landfill waste leaching test concentration Likely	mg/L	350	0.044	27	0.1	0.011	0.127	0.03	0.039
Landfill waste leaching test concentration Maximum	mg/L	833	0.224	99	10	0.14	0.605	1	0.078

DIMENSIONS OF ZONE:

Parameter	Units	Saturated Waste	Unsaturated Waste	Total for Zone
Width (perpendicular to groundwater flow)	m	450	450	450
Length (in direction of groundwater flow)	m	100	100	200
Area	m^2	45,000	45,000	90,000
Waste thickness	m	6	18	-

CONTAMINANTS:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Contaminants Organic Carbon Water Partition Coefficient, Koc	L/kg	-	-	-	3.60E+00	1.29E+01	-	8.32E+01	-
Attenuation partition coefficient Kd Distribution		uniform	uniform	constant	-	-	uniform	-	uniform

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Attenuation partition coefficient Kd Minimum	L/kg	0.5	25	0	-	-	20	-	1
Attenuation partition coefficient Kd Maximum	L/kg	2	250	-	-	-	800	-	600
Attenuation half-life distribution		constant	constant	constant	constant	uniform	constant	uniform	constant
Attenuation half-life Minimum	days	No Decay	No Decay	No Decay	139.8	50.01	No Decay	7.3	No Decay
Attenuation half-life Maximum	days	-	-	-	-	365	-	912.5	-
Contaminants free water diffusion coefficient	m^2/s	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09

HYDROGEOLOGY:

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology unit thickness distribution		uniform	constant	uniform
Hydrogeology unit thickness Minimum	m	5	20	0.5
Hydrogeology unit thickness Maximum	m	10		5
Hydrogeology hydraulic conductivity distribution		triangular	triangular	triangular
Hydrogeology hydraulic conductivity Minimum	m/s	1.05E-08	3.25E-08	1.05E-08
Hydrogeology hydraulic conductivity Likely	m/s	1.34E-06	0.0000128	1.34E-06
Hydrogeology hydraulic conductivity Maximum	m/s	6.60E-06	0.0000625	6.60E-06

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology head	m	81	78	-
Hydrogeology hydraulic gradient distribution	[-]	uniform	uniform	constant
Hydrogeology hydraulic gradient Minimum		0.015	0.002	1
Hydrogeology hydraulic gradient Maximum		0.033	0.003	
Hydrogeology porosity distribution	[-]	uniform	uniform	constant
Hydrogeology porosity Minimum		0.31	0.01	0.2
Hydrogeology porosity Maximum		0.46	0.1	
Hydrogeology tortuosity	[-]	5	5	5
Distribution		constant	constant	constant

ATTENUATION

Parameter	Units	Sand and Gravel	Limestone	Unsat SandG
Attenuation dry bulk density	kg/m3	1590	2265	1590
Attenuation fraction organic carbon distribution		triangular	uniform	triangular
Attenuation fraction organic carbon Minimum	[-]	0.001	0.001	0.001
Attenuation fraction organic carbon Likely	[-]	0.002		0.002
Attenuation fraction organic carbon Maximum	[-]	0.024	0.016	0.024

MODEL RESULTS

Saturated Waste

Uncapped 50 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	4.01E+02	8.30E-02	3.94E+01	2.90E+00	4.48E-02	2.15E-01	2.86E-01	3.76E-02
2	3.86E+02	7.98E-02	3.79E+01	2.79E+00	4.31E-02	2.07E-01	2.75E-01	3.62E-02
4	3.57E+02	7.38E-02	3.51E+01	2.58E+00	3.98E-02	1.92E-01	2.54E-01	3.34E-02
6	3.30E+02	6.83E-02	3.24E+01	2.39E+00	3.69E-02	1.77E-01	2.35E-01	3.09E-02
8	3.05E+02	6.32E-02	3.00E+01	2.21E+00	3.41E-02	1.64E-01	2.18E-01	2.86E-02
10	2.82E+02	5.85E-02	2.78E+01	2.05E+00	3.15E-02	1.52E-01	2.01E-01	2.65E-02
20	1.91E+02	3.96E-02	1.88E+01	1.39E+00	2.14E-02	1.03E-01	1.36E-01	1.80E-02
30	1.30E+02	2.69E-02	1.28E+01	9.40E-01	1.45E-02	6.97E-02	9.25E-02	1.22E-02
40	8.80E+01	1.82E-02	8.65E+00	6.37E-01	9.82E-03	4.73E-02	6.27E-02	8.25E-03
50	5.96E+01	1.23E-02	5.86E+00	4.32E-01	6.66E-03	3.20E-02	4.25E-02	5.59E-03
60	4.04E+01	8.36E-03	3.97E+00	2.93E-01	4.51E-03	2.17E-02	2.88E-02	3.79E-03
70	2.74E+01	5.67E-03	2.69E+00	1.98E-01	3.06E-03	1.47E-02	1.95E-02	2.57E-03
80	1.86E+01	3.84E-03	1.83E+00	1.35E-01	2.07E-03	9.98E-03	1.32E-02	1.74E-03
100	8.53E+00	1.77E-03	8.39E-01	6.18E-02	9.53E-04	4.58E-03	6.08E-03	8.00E-04
150	1.22E+00	2.53E-04	1.20E-01	8.84E-03	1.36E-04	6.56E-04	8.70E-04	1.14E-04
250	2.50E-02	5.17E-06	2.46E-03	1.81E-04	2.79E-06	1.34E-05	1.78E-05	2.34E-06
500	4.51E-07	9.33E-11	4.43E-08	3.26E-09	5.03E-11	2.42E-10	3.21E-10	4.23E-11
750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Capped 50 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	3.87E+02	7.87E-02	3.69E+01	2.97E+00	4.48E-02	2.29E-01	2.97E-01	3.77E-02
2	3.85E+02	7.84E-02	3.67E+01	2.95E+00	4.46E-02	2.28E-01	2.96E-01	3.75E-02
4	3.82E+02	7.77E-02	3.64E+01	2.92E+00	4.42E-02	2.26E-01	2.93E-01	3.72E-02
6	3.78E+02	7.70E-02	3.60E+01	2.90E+00	4.38E-02	2.24E-01	2.90E-01	3.68E-02
8	3.75E+02	7.63E-02	3.57E+01	2.87E+00	4.34E-02	2.22E-01	2.88E-01	3.65E-02
10	3.72E+02	7.56E-02	3.54E+01	2.85E+00	4.30E-02	2.20E-01	2.85E-01	3.62E-02
20	3.55E+02	7.22E-02	3.38E+01	2.72E+00	4.11E-02	2.10E-01	2.72E-01	3.46E-02
30	3.39E+02	6.90E-02	3.23E+01	2.60E+00	3.93E-02	2.01E-01	2.60E-01	3.30E-02
40	3.24E+02	6.59E-02	3.09E+01	2.48E+00	3.75E-02	1.92E-01	2.49E-01	3.16E-02
50	3.10E+02	6.30E-02	2.95E+01	2.37E+00	3.59E-02	1.83E-01	2.38E-01	3.01E-02
60	2.96E+02	6.02E-02	2.82E+01	2.27E+00	3.43E-02	1.75E-01	2.27E-01	2.88E-02
70	2.83E+02	5.75E-02	2.69E+01	2.16E+00	3.27E-02	1.67E-01	2.17E-01	2.75E-02
80	2.70E+02	5.49E-02	2.57E+01	2.07E+00	3.13E-02	1.60E-01	2.07E-01	2.63E-02
100	2.47E+02	5.01E-02	2.35E+01	1.89E+00	2.86E-02	1.46E-01	1.89E-01	2.40E-02
150	1.96E+02	3.99E-02	1.87E+01	1.50E+00	2.27E-02	1.16E-01	1.51E-01	1.91E-02
250	1.24E+02	2.53E-02	1.18E+01	9.53E-01	1.44E-02	7.36E-02	9.54E-02	1.21E-02
500	3.98E+01	8.10E-03	3.79E+00	3.05E-01	4.61E-03	2.35E-02	3.05E-02	3.88E-03
750	1.27E+01	2.59E-03	1.21E+00	9.76E-02	1.48E-03	7.53E-03	9.77E-03	1.24E-03
1000	4.08E+00	8.29E-04	3.88E-01	3.12E-02	4.72E-04	2.41E-03	3.13E-03	3.97E-04
2000	4.27E-02	8.69E-06	4.07E-03	3.27E-04	4.95E-06	2.53E-05	3.28E-05	4.16E-06

Uncapped 95 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	6.71E+02	1.72E-01	7.73E+01	7.60E+00	1.08E-01	4.75E-01	7.42E-01	6.20E-02
2	6.46E+02	1.65E-01	7.43E+01	7.31E+00	1.04E-01	4.57E-01	7.13E-01	5.97E-02
4	5.97E+02	1.53E-01	6.88E+01	6.76E+00	9.64E-02	4.22E-01	6.60E-01	5.52E-02
6	5.53E+02	1.42E-01	6.36E+01	6.26E+00	8.92E-02	3.91E-01	6.11E-01	5.11E-02
8	5.11E+02	1.31E-01	5.89E+01	5.79E+00	8.25E-02	3.62E-01	5.65E-01	4.73E-02
10	4.73E+02	1.21E-01	5.44E+01	5.35E+00	7.64E-02	3.34E-01	5.23E-01	4.37E-02
20	3.21E+02	8.21E-02	3.69E+01	3.63E+00	5.18E-02	2.27E-01	3.54E-01	2.96E-02
30	2.17E+02	5.57E-02	2.50E+01	2.46E+00	3.51E-02	1.54E-01	2.40E-01	2.01E-02
40	1.47E+02	3.77E-02	1.70E+01	1.67E+00	2.38E-02	1.04E-01	1.63E-01	1.36E-02
50	9.98E+01	2.56E-02	1.15E+01	1.13E+00	1.61E-02	7.06E-02	1.10E-01	9.23E-03
60	6.77E+01	1.73E-02	7.79E+00	7.66E-01	1.09E-02	4.79E-02	7.48E-02	6.25E-03
70	4.59E+01	1.17E-02	5.28E+00	5.19E-01	7.41E-03	3.24E-02	5.07E-02	4.24E-03
80	3.11E+01	7.96E-03	3.58E+00	3.52E-01	5.02E-03	2.20E-02	3.44E-02	2.87E-03
100	1.43E+01	3.66E-03	1.64E+00	1.62E-01	2.31E-03	1.01E-02	1.58E-02	1.32E-03
150	2.04E+00	5.23E-04	2.35E-01	2.31E-02	3.30E-04	1.45E-03	2.26E-03	1.89E-04
250	4.18E-02	1.07E-05	4.81E-03	4.73E-04	6.75E-06	2.96E-05	4.62E-05	3.87E-06
500	7.55E-07	1.93E-10	8.69E-08	8.54E-09	1.22E-10	5.34E-10	8.34E-10	6.98E-11
750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Capped 95 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	6.87E+02	1.69E-01	7.60E+01	7.51E+00	1.06E-01	4.61E-01	7.52E-01	6.50E-02
2	6.84E+02	1.68E-01	7.57E+01	7.48E+00	1.06E-01	4.59E-01	7.49E-01	6.47E-02
4	6.78E+02	1.66E-01	7.50E+01	7.41E+00	1.05E-01	4.54E-01	7.42E-01	6.42E-02
6	6.72E+02	1.65E-01	7.43E+01	7.34E+00	1.04E-01	4.50E-01	7.35E-01	6.36E-02
8	6.66E+02	1.63E-01	7.36E+01	7.27E+00	1.03E-01	4.46E-01	7.29E-01	6.30E-02
10	6.60E+02	1.62E-01	7.30E+01	7.21E+00	1.02E-01	4.42E-01	7.22E-01	6.24E-02
20	6.30E+02	1.55E-01	6.97E+01	6.89E+00	9.72E-02	4.23E-01	6.90E-01	5.96E-02
30	6.02E+02	1.48E-01	6.66E+01	6.58E+00	9.29E-02	4.04E-01	6.59E-01	5.70E-02
40	5.75E+02	1.41E-01	6.36E+01	6.29E+00	8.87E-02	3.86E-01	6.30E-01	5.44E-02
50	5.50E+02	1.35E-01	6.08E+01	6.01E+00	8.48E-02	3.69E-01	6.02E-01	5.20E-02
60	5.25E+02	1.29E-01	5.81E+01	5.74E+00	8.10E-02	3.52E-01	5.75E-01	4.97E-02
70	5.02E+02	1.23E-01	5.55E+01	5.48E+00	7.74E-02	3.36E-01	5.49E-01	4.75E-02
80	4.79E+02	1.18E-01	5.30E+01	5.24E+00	7.39E-02	3.21E-01	5.25E-01	4.54E-02
100	4.38E+02	1.07E-01	4.84E+01	4.78E+00	6.75E-02	2.93E-01	4.79E-01	4.14E-02
150	3.49E+02	8.56E-02	3.85E+01	3.81E+00	5.37E-02	2.34E-01	3.82E-01	3.30E-02
250	2.21E+02	5.42E-02	2.44E+01	2.41E+00	3.41E-02	1.48E-01	2.42E-01	2.09E-02
500	7.07E+01	1.74E-02	7.82E+00	7.72E-01	1.09E-02	4.74E-02	7.74E-02	6.69E-03
750	2.26E+01	5.55E-03	2.50E+00	2.47E-01	3.49E-03	1.52E-02	2.48E-02	2.14E-03
1000	7.24E+00	1.78E-03	8.00E-01	7.91E-02	1.12E-03	4.85E-03	7.92E-03	6.85E-04
2000	7.58E-02	1.86E-05	8.39E-03	8.29E-04	1.17E-05	5.08E-05	8.30E-05	7.18E-06

Overburden

Uncapped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	4.32E-11	4.67E-15	4.03E-21	0.00E+00	4.00E-40	0.00E+00
4	4.95E-21	0.00E+00	6.70E-03	5.33E-07	3.32E-10	0.00E+00	2.45E-20	0.00E+00
6	2.75E-14	0.00E+00	3.51E-01	3.98E-06	1.91E-08	0.00E+00	4.52E-14	0.00E+00
8	1.75E-09	0.00E+00	1.72E+00	4.48E-06	5.38E-08	0.00E+00	1.97E-11	0.00E+00
10	7.21E-07	0.00E+00	3.70E+00	4.19E-06	7.41E-08	0.00E+00	4.19E-10	0.00E+00
20	6.58E-02	0.00E+00	1.05E+01	2.84E-06	6.09E-08	0.00E+00	1.63E-08	0.00E+00
30	2.12E+00	0.00E+00	1.18E+01	1.93E-06	4.14E-08	0.00E+00	2.43E-08	0.00E+00
40	1.02E+01	0.00E+00	1.14E+01	1.31E-06	2.80E-08	0.00E+00	1.75E-08	0.00E+00
50	2.10E+01	0.00E+00	9.86E+00	8.85E-07	1.90E-08	0.00E+00	1.19E-08	0.00E+00
60	3.01E+01	0.00E+00	7.74E+00	6.00E-07	1.29E-08	0.00E+00	8.05E-09	0.00E+00
70	3.54E+01	0.00E+00	5.87E+00	4.07E-07	8.73E-09	0.00E+00	5.46E-09	0.00E+00
80	3.67E+01	0.00E+00	4.36E+00	2.76E-07	5.92E-09	0.00E+00	3.70E-09	0.00E+00
100	3.69E+01	0.00E+00	2.26E+00	1.27E-07	2.72E-09	0.00E+00	1.70E-09	0.00E+00
150	2.85E+01	2.50E-38	3.66E-01	1.81E-08	3.89E-10	0.00E+00	2.43E-10	0.00E+00
250	1.42E+01	2.26E-28	7.69E-03	3.71E-10	7.96E-12	0.00E+00	4.98E-12	0.00E+00
500	1.21E+00	2.16E-16	4.07E-07	6.93E-15	1.85E-16	1.73E-34	2.06E-16	3.65E-28
750	4.89E-02	1.75E-11	0.00E+00	0.00E+00	0.00E+00	1.35E-27	0.00E+00	1.07E-21
1000	1.93E-03	3.91E-09	0.00E+00	0.00E+00	0.00E+00	4.37E-22	0.00E+00	6.59E-17
2000	3.95E-08	7.35E-06	0.00E+00	0.00E+00	0.00E+00	2.52E-12	0.00E+00	1.23E-09

Capped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	2.87E-11	6.49E-15	1.21E-20	0.00E+00	0.00E+00	0.00E+00
4	1.30E-20	0.00E+00	4.52E-03	3.74E-07	3.79E-10	0.00E+00	4.52E-19	0.00E+00
6	2.08E-14	0.00E+00	2.08E-01	2.67E-06	1.47E-08	0.00E+00	4.63E-13	0.00E+00
8	1.17E-09	0.00E+00	9.66E-01	3.29E-06	4.16E-08	0.00E+00	1.08E-10	0.00E+00
10	5.37E-07	0.00E+00	1.98E+00	3.29E-06	6.17E-08	0.00E+00	1.51E-09	0.00E+00
20	4.65E-02	0.00E+00	5.45E+00	3.15E-06	6.85E-08	0.00E+00	6.58E-08	0.00E+00
30	1.54E+00	0.00E+00	7.88E+00	3.01E-06	6.55E-08	0.00E+00	1.11E-07	0.00E+00
40	7.09E+00	0.00E+00	9.53E+00	2.87E-06	6.26E-08	0.00E+00	1.14E-07	0.00E+00
50	1.57E+01	0.00E+00	1.06E+01	2.75E-06	5.98E-08	0.00E+00	1.11E-07	0.00E+00
60	2.43E+01	0.00E+00	1.16E+01	2.62E-06	5.71E-08	0.00E+00	1.06E-07	0.00E+00
70	3.10E+01	0.00E+00	1.20E+01	2.51E-06	5.46E-08	0.00E+00	1.02E-07	0.00E+00
80	3.63E+01	0.00E+00	1.21E+01	2.39E-06	5.21E-08	0.00E+00	9.71E-08	0.00E+00
100	4.47E+01	0.00E+00	1.19E+01	2.19E-06	4.76E-08	0.00E+00	8.86E-08	0.00E+00
150	5.31E+01	6.51E-39	1.03E+01	1.74E-06	3.79E-08	0.00E+00	7.06E-08	0.00E+00
250	5.57E+01	5.83E-27	6.76E+00	1.10E-06	2.40E-08	0.00E+00	4.47E-08	0.00E+00
500	4.24E+01	4.13E-17	2.17E+00	3.53E-07	7.69E-09	3.96E-34	1.43E-08	1.92E-27
750	2.06E+01	8.19E-12	6.97E-01	1.13E-07	2.46E-09	1.90E-26	4.58E-09	6.40E-22
1000	7.50E+00	3.26E-09	2.23E-01	3.61E-08	7.87E-10	5.31E-21	1.47E-09	5.99E-18
2000	8.29E-02	1.52E-05	2.34E-03	3.79E-10	8.25E-12	2.32E-11	1.54E-11	6.97E-10

Uncapped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.27E-28	2.85E-31	2.00E-37	0.00E+00	0.00E+00	0.00E+00
2	1.25E-19	0.00E+00	1.18E-03	3.12E-06	2.35E-09	0.00E+00	2.63E-16	0.00E+00
4	1.15E-06	0.00E+00	2.40E+00	1.29E-03	1.62E-05	0.00E+00	4.71E-07	0.00E+00
6	5.00E-03	0.00E+00	8.65E+00	1.53E-03	4.57E-05	0.00E+00	3.22E-05	0.00E+00
8	1.91E-01	0.00E+00	1.45E+01	1.42E-03	5.73E-05	0.00E+00	1.89E-04	0.00E+00
10	1.33E+00	0.00E+00	1.89E+01	1.32E-03	5.99E-05	0.00E+00	4.29E-04	0.00E+00
20	3.53E+01	7.59E-41	2.83E+01	8.93E-04	4.21E-05	0.00E+00	7.08E-04	0.00E+00
30	7.44E+01	9.10E-34	2.79E+01	6.06E-04	2.86E-05	0.00E+00	5.05E-04	2.96E-37
40	9.21E+01	4.99E-31	2.46E+01	4.10E-04	1.94E-05	6.83E-40	3.43E-04	2.00E-31
50	9.80E+01	1.30E-26	2.13E+01	2.78E-04	1.31E-05	1.02E-34	2.32E-04	5.84E-31
60	9.63E+01	1.94E-23	1.80E+01	1.89E-04	8.89E-06	1.70E-31	1.57E-04	9.46E-27
70	9.27E+01	2.95E-22	1.51E+01	1.28E-04	6.03E-06	3.96E-27	1.07E-04	7.91E-24
80	8.71E+01	3.24E-20	1.28E+01	8.66E-05	4.08E-06	2.88E-30	7.23E-05	1.21E-21
100	7.72E+01	6.45E-18	9.18E+00	3.98E-05	1.88E-06	5.51E-22	3.32E-05	5.72E-20
150	5.42E+01	3.41E-12	4.04E+00	5.69E-06	2.68E-07	1.39E-17	4.75E-06	1.92E-13
250	3.27E+01	8.84E-08	9.11E-01	1.17E-07	5.50E-09	7.43E-11	9.73E-08	1.22E-08
500	1.25E+01	7.21E-05	7.13E-03	1.95E-12	1.14E-13	5.34E-06	3.23E-12	1.99E-05
750	6.41E+00	3.55E-04	6.17E-05	0.00E+00	0.00E+00	1.03E-04	3.67E-21	1.04E-04
1000	3.57E+00	5.14E-04	4.21E-07	0.00E+00	0.00E+00	4.29E-04	3.25E-27	1.56E-04
2000	1.99E-01	5.03E-04	0.00E+00	0.00E+00	0.00E+00	8.61E-04	0.00E+00	1.91E-04

Capped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	3.25E-29	1.44E-31	5.46E-38	0.00E+00	0.00E+00	0.00E+00
2	5.47E-20	0.00E+00	3.91E-04	8.10E-07	1.04E-09	0.00E+00	3.37E-17	0.00E+00
4	2.08E-07	0.00E+00	8.52E-01	4.77E-04	1.05E-05	0.00E+00	3.38E-07	0.00E+00
6	1.19E-03	0.00E+00	3.54E+00	6.48E-04	3.42E-05	0.00E+00	2.81E-05	0.00E+00
8	4.99E-02	0.00E+00	6.20E+00	6.45E-04	4.08E-05	0.00E+00	1.51E-04	0.00E+00
10	4.14E-01	0.00E+00	8.15E+00	6.40E-04	4.17E-05	0.00E+00	3.16E-04	0.00E+00
20	1.63E+01	0.00E+00	1.43E+01	6.11E-04	3.98E-05	0.00E+00	6.35E-04	0.00E+00
30	4.11E+01	9.68E-34	1.79E+01	5.84E-04	3.81E-05	0.00E+00	6.08E-04	2.16E-35
40	5.98E+01	3.26E-31	2.11E+01	5.58E-04	3.64E-05	0.00E+00	5.81E-04	5.91E-32
50	7.38E+01	1.93E-26	2.35E+01	5.33E-04	3.47E-05	2.07E-38	5.55E-04	3.30E-28
60	8.26E+01	2.53E-24	2.57E+01	5.09E-04	3.32E-05	1.92E-32	5.30E-04	3.76E-24
70	8.77E+01	2.94E-23	2.69E+01	4.87E-04	3.17E-05	1.07E-31	5.07E-04	1.01E-22
80	9.34E+01	1.07E-21	2.73E+01	4.65E-04	3.03E-05	6.54E-31	4.84E-04	1.82E-20
100	1.03E+02	8.44E-20	2.77E+01	4.24E-04	2.77E-05	8.58E-26	4.42E-04	9.35E-18
150	1.15E+02	2.15E-13	2.49E+01	3.38E-04	2.20E-05	6.64E-21	3.52E-04	2.96E-12
250	1.24E+02	1.35E-08	1.87E+01	2.14E-04	1.40E-05	1.46E-13	2.23E-04	5.20E-08
500	9.63E+01	4.33E-05	6.34E+00	6.85E-05	4.47E-06	2.82E-07	7.14E-05	6.02E-05
750	6.98E+01	5.02E-04	2.14E+00	2.19E-05	1.43E-06	3.85E-05	2.28E-05	4.43E-04
1000	4.84E+01	1.24E-03	6.95E-01	7.02E-06	4.57E-07	2.65E-04	7.31E-06	5.29E-04
2000	7.64E+00	1.93E-03	7.28E-03	7.35E-08	4.79E-09	2.46E-03	7.66E-08	6.00E-04

Overburden at the River Morell

Uncapped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	8.53E-18	3.37E-24	3.11E-32	0.00E+00	0.00E+00	0.00E+00
4	2.19E-32	0.00E+00	6.39E-06	1.43E-10	8.28E-15	0.00E+00	3.11E-30	0.00E+00
6	2.62E-22	0.00E+00	5.80E-03	1.83E-08	1.46E-11	0.00E+00	2.34E-21	0.00E+00
8	3.19E-16	0.00E+00	1.06E-01	4.39E-08	1.73E-10	0.00E+00	4.56E-17	0.00E+00
10	4.12E-13	0.00E+00	5.02E-01	4.69E-08	5.29E-10	0.00E+00	1.24E-14	0.00E+00
20	6.32E-05	0.00E+00	5.97E+00	3.22E-08	6.51E-10	0.00E+00	2.22E-11	0.00E+00
30	2.38E-02	0.00E+00	9.87E+00	2.19E-08	4.56E-10	0.00E+00	1.05E-10	0.00E+00
40	4.31E-01	0.00E+00	1.04E+01	1.48E-08	3.09E-10	0.00E+00	9.53E-11	0.00E+00
50	2.13E+00	0.00E+00	9.70E+00	1.00E-08	2.09E-10	0.00E+00	7.21E-11	0.00E+00
60	5.59E+00	0.00E+00	8.43E+00	6.80E-09	1.42E-10	0.00E+00	4.89E-11	0.00E+00
70	1.11E+01	0.00E+00	6.77E+00	4.61E-09	9.62E-11	0.00E+00	3.31E-11	0.00E+00
80	1.62E+01	0.00E+00	5.28E+00	3.13E-09	6.52E-11	0.00E+00	2.24E-11	0.00E+00
100	2.46E+01	0.00E+00	2.91E+00	1.44E-09	3.00E-11	0.00E+00	1.03E-11	0.00E+00
150	2.73E+01	0.00E+00	5.30E-01	2.05E-10	4.29E-12	0.00E+00	1.48E-12	0.00E+00
250	1.57E+01	2.75E-36	1.19E-02	4.21E-12	8.77E-14	0.00E+00	3.02E-14	0.00E+00
500	2.70E+00	1.87E-24	7.15E-07	8.63E-17	2.51E-18	0.00E+00	1.37E-18	6.36E-36
750	2.25E-01	4.37E-18	0.00E+00	0.00E+00	0.00E+00	8.99E-36	0.00E+00	1.12E-31
1000	1.77E-02	5.00E-14	0.00E+00	0.00E+00	0.00E+00	1.01E-31	0.00E+00	2.16E-25
2000	6.83E-07	3.61E-08	0.00E+00	0.00E+00	0.00E+00	4.12E-20	0.00E+00	1.40E-14

Capped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	8.42E-18	8.43E-23	1.13E-30	0.00E+00	0.00E+00	0.00E+00
4	6.03E-32	0.00E+00	4.79E-06	1.42E-10	1.63E-14	0.00E+00	4.80E-29	0.00E+00
6	1.71E-22	0.00E+00	3.96E-03	1.32E-08	1.42E-11	0.00E+00	4.83E-20	0.00E+00
8	1.95E-16	0.00E+00	6.28E-02	3.19E-08	1.92E-10	0.00E+00	6.84E-16	0.00E+00
10	2.94E-13	0.00E+00	3.04E-01	3.69E-08	4.00E-10	0.00E+00	1.24E-13	0.00E+00
20	4.86E-05	0.00E+00	3.14E+00	3.57E-08	8.13E-10	0.00E+00	2.04E-10	0.00E+00
30	1.78E-02	0.00E+00	5.52E+00	3.41E-08	8.07E-10	0.00E+00	6.78E-10	0.00E+00
40	3.15E-01	0.00E+00	7.33E+00	3.26E-08	7.71E-10	0.00E+00	7.37E-10	0.00E+00
50	1.65E+00	0.00E+00	9.13E+00	3.12E-08	7.37E-10	0.00E+00	7.33E-10	0.00E+00
60	4.64E+00	0.00E+00	1.01E+01	2.98E-08	7.04E-10	0.00E+00	7.18E-10	0.00E+00
70	8.67E+00	0.00E+00	1.08E+01	2.85E-08	6.73E-10	0.00E+00	6.87E-10	0.00E+00
80	1.38E+01	0.00E+00	1.12E+01	2.72E-08	6.43E-10	0.00E+00	6.57E-10	0.00E+00
100	2.38E+01	0.00E+00	1.15E+01	2.48E-08	5.87E-10	0.00E+00	6.00E-10	0.00E+00
150	3.80E+01	0.00E+00	1.04E+01	1.98E-08	4.67E-10	0.00E+00	4.77E-10	0.00E+00
250	5.05E+01	1.87E-38	6.99E+00	1.25E-08	2.96E-10	0.00E+00	3.03E-10	0.00E+00
500	4.40E+01	1.09E-23	2.27E+00	4.01E-09	9.47E-11	0.00E+00	9.68E-11	3.94E-39
750	2.44E+01	3.64E-19	7.27E-01	1.28E-09	3.03E-11	3.81E-36	3.10E-11	3.01E-31
1000	9.54E+00	1.79E-14	2.33E-01	4.10E-10	9.70E-12	3.55E-32	9.91E-12	1.83E-24
2000	1.11E-01	5.19E-08	2.44E-03	4.30E-12	1.02E-13	2.73E-18	1.04E-13	2.80E-15

Uncapped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.83E-38	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	9.66E-27	0.00E+00	4.04E-07	3.62E-10	3.34E-14	0.00E+00	3.93E-23	0.00E+00
4	6.01E-13	0.00E+00	1.66E-01	3.67E-05	2.04E-07	0.00E+00	8.17E-11	0.00E+00
6	8.71E-07	0.00E+00	2.26E+00	8.89E-05	2.32E-06	0.00E+00	1.00E-07	0.00E+00
8	3.78E-04	0.00E+00	6.08E+00	9.14E-05	3.98E-06	0.00E+00	2.86E-06	0.00E+00
10	1.17E-02	0.00E+00	1.00E+01	8.48E-05	5.37E-06	0.00E+00	1.42E-05	0.00E+00
20	4.98E+00	0.00E+00	2.41E+01	5.75E-05	3.95E-06	0.00E+00	7.74E-05	0.00E+00
30	2.58E+01	0.00E+00	2.67E+01	3.89E-05	2.68E-06	0.00E+00	6.29E-05	0.00E+00
40	5.01E+01	5.88E-37	2.51E+01	2.64E-05	1.82E-06	0.00E+00	4.39E-05	8.65E-41
50	6.58E+01	3.03E-33	2.22E+01	1.79E-05	1.23E-06	0.00E+00	2.98E-05	2.26E-35
60	7.66E+01	5.04E-31	1.97E+01	1.21E-05	8.34E-07	2.29E-38	2.02E-05	3.63E-34
70	8.15E+01	2.22E-30	1.69E+01	8.22E-06	5.66E-07	3.06E-35	1.37E-05	6.40E-31
80	8.28E+01	1.29E-26	1.46E+01	5.57E-06	3.83E-07	4.63E-35	9.28E-06	4.38E-31
100	7.87E+01	1.12E-23	1.12E+01	2.56E-06	1.76E-07	7.96E-32	4.26E-06	3.68E-27
150	6.12E+01	9.48E-20	5.44E+00	3.66E-07	2.52E-08	1.13E-23	6.10E-07	1.81E-20
250	3.96E+01	3.24E-12	1.54E+00	7.50E-09	5.16E-10	1.46E-17	1.25E-08	1.85E-13
500	1.62E+01	7.97E-07	3.35E-02	1.32E-13	1.24E-14	2.81E-09	6.17E-13	1.26E-07
750	8.58E+00	2.49E-05	7.37E-04	0.00E+00	0.00E+00	1.20E-06	4.08E-21	6.56E-06
1000	4.91E+00	1.11E-04	1.51E-05	0.00E+00	0.00E+00	1.79E-05	4.28E-25	3.61E-05
2000	5.30E-01	3.93E-04	1.49E-09	0.00E+00	0.00E+00	3.85E-04	0.00E+00	1.17E-04

Capped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	7.77E-39	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	5.43E-24	0.00E+00	1.27E-07	6.70E-11	8.97E-15	0.00E+00	3.15E-22	0.00E+00
4	6.29E-14	0.00E+00	6.20E-02	1.30E-05	1.16E-07	0.00E+00	4.02E-11	0.00E+00
6	1.56E-07	0.00E+00	8.10E-01	3.51E-05	1.78E-06	0.00E+00	1.23E-07	0.00E+00
8	8.60E-05	0.00E+00	2.35E+00	3.65E-05	3.25E-06	0.00E+00	2.37E-06	0.00E+00
10	2.85E-03	0.00E+00	4.11E+00	3.63E-05	3.57E-06	0.00E+00	1.10E-05	0.00E+00
20	1.96E+00	0.00E+00	1.02E+01	3.46E-05	3.71E-06	0.00E+00	6.92E-05	0.00E+00
30	1.21E+01	0.00E+00	1.50E+01	3.31E-05	3.54E-06	0.00E+00	7.26E-05	0.00E+00
40	2.73E+01	2.08E-38	1.87E+01	3.16E-05	3.39E-06	0.00E+00	7.21E-05	4.61E-40
50	4.09E+01	5.28E-34	2.11E+01	3.02E-05	3.24E-06	0.00E+00	6.89E-05	3.01E-35
60	5.36E+01	2.16E-31	2.27E+01	2.89E-05	3.09E-06	0.00E+00	6.58E-05	1.78E-34
70	6.28E+01	7.43E-31	2.50E+01	2.76E-05	2.95E-06	0.00E+00	6.29E-05	3.62E-31
80	7.02E+01	8.41E-27	2.58E+01	2.64E-05	2.82E-06	2.52E-38	6.01E-05	2.64E-31
100	8.06E+01	3.78E-24	2.63E+01	2.41E-05	2.58E-06	1.59E-33	5.48E-05	2.93E-24
150	9.86E+01	2.80E-20	2.53E+01	1.92E-05	2.05E-06	3.10E-30	4.37E-05	4.32E-20
250	1.14E+02	2.26E-13	1.99E+01	1.21E-05	1.30E-06	1.46E-20	2.77E-05	3.08E-12
500	9.85E+01	2.17E-07	7.15E+00	3.89E-06	4.16E-07	1.85E-11	8.86E-06	5.53E-07
750	7.62E+01	1.69E-05	2.49E+00	1.24E-06	1.33E-07	5.45E-08	2.83E-06	2.56E-05
1000	5.64E+01	1.31E-04	8.11E-01	3.98E-07	4.26E-08	2.71E-06	9.07E-07	1.46E-04
2000	1.24E+01	1.14E-03	8.50E-03	4.17E-09	4.46E-10	5.39E-04	9.50E-09	4.20E-04

JACOBS

Limestone Aquifer

Uncapped 50 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	3.44E-06	2.80E-15	1.02E-28	0.00E+00	0.00E+00	0.00E+00
4	0.00E+00	0.00E+00	1.08E+00	3.25E-06	2.02E-13	0.00E+00	7.79E-39	0.00E+00
6	1.44E-30	0.00E+00	6.72E+00	2.35E-05	2.20E-10	0.00E+00	2.02E-30	0.00E+00
8	2.51E-26	0.00E+00	1.22E+01	2.63E-05	2.50E-09	0.00E+00	5.02E-24	0.00E+00
10	5.21E-22	0.00E+00	1.55E+01	2.44E-05	6.05E-09	0.00E+00	3.76E-20	0.00E+00
20	4.06E-11	0.00E+00	1.81E+01	1.66E-05	8.14E-09	0.00E+00	8.78E-14	0.00E+00
30	5.80E-06	0.00E+00	1.34E+01	1.12E-05	5.52E-09	0.00E+00	1.10E-12	0.00E+00
40	1.66E-03	0.00E+00	9.48E+00	7.61E-06	3.74E-09	0.00E+00	2.07E-12	0.00E+00
50	4.10E-02	0.00E+00	6.55E+00	5.16E-06	2.53E-09	0.00E+00	1.66E-12	0.00E+00
60	2.89E-01	0.00E+00	4.46E+00	3.50E-06	1.72E-09	0.00E+00	1.20E-12	0.00E+00
70	1.06E+00	0.00E+00	3.04E+00	2.37E-06	1.16E-09	0.00E+00	8.25E-13	0.00E+00
80	2.67E+00	0.00E+00	2.06E+00	1.61E-06	7.89E-10	0.00E+00	5.59E-13	0.00E+00
100	8.14E+00	0.00E+00	9.47E-01	7.38E-07	3.63E-10	0.00E+00	2.57E-13	0.00E+00
150	1.96E+01	0.00E+00	1.36E-01	1.06E-07	5.19E-11	0.00E+00	3.67E-14	0.00E+00
250	1.60E+01	0.00E+00	2.77E-03	2.16E-09	1.06E-12	0.00E+00	7.52E-16	0.00E+00
500	4.59E+00	3.63E-35	7.20E-08	3.89E-14	2.90E-17	0.00E+00	4.30E-20	0.00E+00
750	6.80E-01	2.70E-30	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	8.49E-02	2.52E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.64E-35
2000	1.64E-05	1.33E-14	0.00E+00	0.00E+00	0.00E+00	1.59E-30	0.00E+00	1.96E-26

Capped 50 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	4.52E-06	7.54E-15	1.03E-29	0.00E+00	0.00E+00	0.00E+00
4	0.00E+00	0.00E+00	5.74E-01	1.95E-06	2.79E-13	0.00E+00	0.00E+00	0.00E+00
6	9.58E-33	0.00E+00	2.54E+00	1.16E-05	1.99E-10	0.00E+00	5.72E-30	0.00E+00
8	5.53E-28	0.00E+00	3.71E+00	1.34E-05	1.93E-09	0.00E+00	4.05E-23	0.00E+00
10	1.93E-22	0.00E+00	4.71E+00	1.33E-05	4.84E-09	0.00E+00	1.78E-19	0.00E+00
20	2.83E-10	0.00E+00	7.12E+00	1.27E-05	7.79E-09	0.00E+00	3.73E-13	0.00E+00
30	1.40E-05	0.00E+00	8.80E+00	1.21E-05	7.45E-09	0.00E+00	3.88E-12	0.00E+00
40	2.10E-03	0.00E+00	9.22E+00	1.16E-05	7.11E-09	0.00E+00	6.63E-12	0.00E+00
50	3.85E-02	0.00E+00	9.02E+00	1.11E-05	6.80E-09	0.00E+00	7.76E-12	0.00E+00
60	2.37E-01	0.00E+00	8.76E+00	1.06E-05	6.49E-09	0.00E+00	7.52E-12	0.00E+00
70	8.68E-01	0.00E+00	8.51E+00	1.01E-05	6.20E-09	0.00E+00	7.19E-12	0.00E+00
80	1.98E+00	0.00E+00	8.18E+00	9.66E-06	5.93E-09	0.00E+00	6.87E-12	0.00E+00
100	6.17E+00	0.00E+00	7.51E+00	8.82E-06	5.41E-09	0.00E+00	6.27E-12	0.00E+00
150	1.90E+01	0.00E+00	5.98E+00	7.02E-06	4.31E-09	0.00E+00	4.99E-12	0.00E+00
250	2.99E+01	0.00E+00	3.79E+00	4.45E-06	2.73E-09	0.00E+00	3.16E-12	0.00E+00
500	2.76E+01	4.60E-38	1.21E+00	1.42E-06	8.74E-10	0.00E+00	1.01E-12	0.00E+00
750	1.63E+01	7.14E-31	3.88E-01	4.56E-07	2.80E-10	0.00E+00	3.24E-13	0.00E+00
1000	7.46E+00	2.19E-25	1.24E-01	1.46E-07	8.95E-11	0.00E+00	1.04E-13	3.03E-37
2000	1.00E-01	1.34E-14	1.30E-03	1.53E-09	9.38E-13	2.26E-31	1.09E-15	2.26E-26

Uncapped 95 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.63E-22	4.36E-32	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	6.24E-35	0.00E+00	9.72E-01	1.22E-05	6.25E-13	0.00E+00	5.65E-30	0.00E+00
4	8.33E-19	0.00E+00	1.85E+01	5.06E-03	3.76E-06	0.00E+00	1.72E-16	0.00E+00
6	1.21E-14	0.00E+00	3.12E+01	5.22E-03	3.23E-05	0.00E+00	9.46E-11	0.00E+00
8	1.27E-09	0.00E+00	3.66E+01	4.86E-03	4.62E-05	0.00E+00	1.72E-08	0.00E+00
10	1.48E-06	0.00E+00	3.98E+01	4.49E-03	4.52E-05	0.00E+00	2.15E-07	0.00E+00
20	2.19E-01	0.00E+00	3.85E+01	3.05E-03	3.17E-05	0.00E+00	1.10E-05	0.00E+00
30	5.19E+00	0.00E+00	2.88E+01	2.06E-03	2.15E-05	0.00E+00	1.13E-05	0.00E+00
40	2.23E+01	0.00E+00	2.08E+01	1.40E-03	1.46E-05	0.00E+00	7.84E-06	0.00E+00
50	3.92E+01	0.00E+00	1.47E+01	9.48E-04	9.88E-06	0.00E+00	5.32E-06	0.00E+00
60	5.31E+01	0.00E+00	1.04E+01	6.43E-04	6.70E-06	0.00E+00	3.60E-06	0.00E+00
70	6.26E+01	0.00E+00	7.16E+00	4.36E-04	4.54E-06	0.00E+00	2.44E-06	0.00E+00
80	6.73E+01	9.52E-38	5.04E+00	2.95E-04	3.08E-06	0.00E+00	1.66E-06	3.37E-39
100	6.50E+01	2.05E-33	2.40E+00	1.36E-04	1.41E-06	0.00E+00	7.61E-07	8.77E-34
150	5.59E+01	3.90E-30	3.47E-01	1.94E-05	2.02E-07	2.82E-34	1.09E-07	4.92E-30
250	3.53E+01	2.24E-22	7.18E-03	3.97E-07	4.14E-09	1.45E-29	2.23E-09	1.23E-22
500	1.64E+01	1.60E-13	3.60E-07	6.66E-12	8.55E-14	1.60E-18	8.74E-14	2.33E-12
750	9.23E+00	2.95E-09	0.00E+00	0.00E+00	0.00E+00	1.27E-13	5.19E-20	1.35E-08
1000	5.40E+00	2.74E-07	0.00E+00	0.00E+00	0.00E+00	3.43E-10	1.80E-24	6.87E-07
2000	1.13E+00	7.99E-05	0.00E+00	0.00E+00	0.00E+00	8.11E-06	0.00E+00	3.51E-05

Capped 95 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	7.26E-23	4.80E-35	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	2.42E-37	0.00E+00	2.47E-01	1.70E-06	1.38E-13	0.00E+00	1.43E-30	0.00E+00
4	2.68E-21	0.00E+00	5.46E+00	1.28E-03	9.18E-07	0.00E+00	1.31E-16	0.00E+00
6	2.35E-15	0.00E+00	8.47E+00	1.51E-03	9.98E-06	0.00E+00	1.02E-10	0.00E+00
8	3.81E-11	0.00E+00	1.05E+01	1.50E-03	1.76E-05	0.00E+00	2.07E-08	0.00E+00
10	6.01E-08	0.00E+00	1.16E+01	1.49E-03	2.17E-05	0.00E+00	2.42E-07	0.00E+00
20	3.15E-02	0.00E+00	1.77E+01	1.42E-03	2.26E-05	0.00E+00	8.20E-06	0.00E+00
30	1.27E+00	0.00E+00	2.07E+01	1.36E-03	2.16E-05	0.00E+00	1.05E-05	0.00E+00
40	6.70E+00	0.00E+00	2.18E+01	1.30E-03	2.07E-05	0.00E+00	1.01E-05	0.00E+00
50	1.57E+01	0.00E+00	2.18E+01	1.24E-03	1.97E-05	0.00E+00	9.68E-06	0.00E+00
60	2.45E+01	0.00E+00	2.14E+01	1.18E-03	1.89E-05	0.00E+00	9.24E-06	0.00E+00
70	3.21E+01	0.00E+00	2.09E+01	1.13E-03	1.80E-05	0.00E+00	8.83E-06	0.00E+00
80	3.89E+01	2.63E-39	2.02E+01	1.08E-03	1.72E-05	0.00E+00	8.44E-06	1.12E-39
100	4.90E+01	8.19E-35	1.85E+01	9.85E-04	1.57E-05	0.00E+00	7.70E-06	3.19E-35
150	6.18E+01	1.28E-30	1.49E+01	7.85E-04	1.25E-05	0.00E+00	6.13E-06	7.40E-31
250	7.36E+01	7.49E-24	9.43E+00	4.97E-04	7.93E-06	1.11E-31	3.89E-06	1.36E-20
500	6.48E+01	2.06E-14	3.02E+00	1.59E-04	2.54E-06	3.46E-22	1.24E-06	3.45E-12
750	4.90E+01	9.92E-10	9.65E-01	5.09E-05	8.12E-07	2.78E-16	3.98E-07	2.18E-08
1000	3.46E+01	1.96E-07	3.09E-01	1.63E-05	2.60E-07	3.66E-12	1.27E-07	1.19E-06
2000	7.90E+00	1.38E-04	3.24E-03	1.71E-07	2.72E-09	1.68E-06	1.33E-09	1.50E-04

Appendix B. Zone 2A specific input parameters and results

MODEL INPUTS

LANDFILL WASTE:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Distribution		triangular	triangular	triangular	triangular	triangular	triangular	triangular	triangular
Landfill waste leaching test concentration Minimum	mg/L	0.05	0.0025	0.47	0.0001	0.001	0.003	0.001	0.0025
Landfill waste leaching test concentration Likely	mg/L	50	0.044	27	0.1	0.011	0.127	0.03	0.039
Landfill waste leaching test concentration Maximum	mg/L	100	0.224	99	10	0.14	0.605	1	0.078

DIMENSIONS OF ZONE:

Parameter	Units	Saturated Waste	Unsaturated Waste	Total for Zone
Width (perpendicular to groundwater flow)	m	Assumed that there is no saturated waste	180	180
Length (in direction of groundwater flow)	m		100	100
Area	m^2		18,000	18,000
Waste thickness	m		8	-

CONTAMINANTS:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Contaminants Organic Carbon Water Partition Coefficient, Koc	L/kg	-	-	-	3.60E+00	1.29E+01	-	8.32E+01	-
Attenuation partition coefficient Kd Distribution		uniform	uniform	constant	-	-	uniform	-	uniform

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Attenuation partition coefficient Kd Minimum	L/kg	0.5	25	0	-	-	20	-	1
Attenuation partition coefficient Kd Maximum	L/kg	2	125	-	-	-	400	-	300
Attenuation half-life distribution		constant	constant	constant	constant	uniform	constant	uniform	constant
Attenuation half-life Minimum	days	No Decay	No Decay	No Decay	139.8	50.01	No Decay	7.3	No Decay
Attenuation half-life Maximum	days	-	-	-	-	365	-	912.5	-
Contaminants free water diffusion coefficient	m^2/s	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09

HYDROGEOLOGY:

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology unit thickness distribution		uniform	constant	constant
Hydrogeology unit thickness Minimum	m	10	20	2
Hydrogeology unit thickness Maximum	m	12		
Hydrogeology hydraulic conductivity distribution		triangular	triangular	triangular
Hydrogeology hydraulic conductivity Minimum	m/s	2.31E-05	3.25E-08	2.31E-05
Hydrogeology hydraulic conductivity Likely	m/s	6.60E-05	0.0000128	6.60E-05
Hydrogeology hydraulic conductivity Maximum	m/s	1.56E-04	0.0000625	1.56E-04

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology head	m	80.5	78	-
Hydrogeology hydraulic gradient distribution	[-]	uniform	uniform	constant
Hydrogeology hydraulic gradient Minimum		0.004	0.002	1
Hydrogeology hydraulic gradient Maximum		0.006	0.003	
Hydrogeology porosity distribution	[-]	uniform	uniform	constant
Hydrogeology porosity Minimum		0.31	0.01	0.2
Hydrogeology porosity Maximum		0.46	0.1	
Hydrogeology tortuosity	[-]	5	5	5
Distribution		constant	constant	constant

ATTENUATION

Parameter	Units	Sand and Gravel	Limestone	Unsat SandG
Attenuation dry bulk density	kg/m3	1590	2265	1590
Attenuation fraction organic carbon distribution		triangular	uniform	triangular
Attenuation fraction organic carbon Minimum	[-]	0.001	0.001	0.001
Attenuation fraction organic carbon Likely	[-]	0.002		0.002
Attenuation fraction organic carbon Maximum	[-]	0.024	0.016	0.024

MODEL RESULTS

Overburden

Uncapped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	9.67E-21	0.00E+00	2.56E-05	5.01E-07	5.87E-10	0.00E+00	1.52E-17	0.00E+00
2	1.03E-03	0.00E+00	6.69E-03	2.41E-04	3.50E-06	0.00E+00	8.85E-06	0.00E+00
4	5.61E-03	5.52E-32	1.69E+00	6.14E-04	5.78E-06	0.00E+00	1.58E-05	0.00E+00
6	6.19E-03	1.68E-23	6.55E+00	7.74E-04	1.17E-05	6.84E-40	1.55E-05	4.87E-35
8	6.26E-03	2.38E-19	8.35E+00	6.60E-04	1.42E-05	2.27E-34	1.55E-05	4.70E-28
10	6.69E-03	4.11E-16	8.05E+00	5.54E-04	1.28E-05	2.03E-29	1.60E-05	5.55E-25
20	5.95E-01	5.39E-10	3.70E+00	2.31E-04	5.38E-06	1.64E-18	1.14E-05	2.29E-15
30	2.98E+00	3.66E-08	1.54E+00	9.63E-05	2.24E-06	1.54E-13	5.14E-06	9.19E-12
40	3.57E+00	2.30E-07	6.43E-01	4.02E-05	9.35E-07	3.43E-11	2.14E-06	4.90E-10
50	2.98E+00	6.11E-07	2.68E-01	1.67E-05	3.90E-07	9.05E-10	9.06E-07	4.47E-09
60	1.85E+00	8.92E-07	1.12E-01	6.98E-06	1.63E-07	6.87E-09	3.78E-07	1.85E-08
70	9.77E-01	1.02E-06	4.66E-02	2.91E-06	6.77E-08	3.01E-08	1.58E-07	4.79E-08
80	4.81E-01	1.03E-06	1.94E-02	1.21E-06	2.82E-08	8.48E-08	6.57E-08	7.81E-08
100	9.83E-02	9.23E-07	3.37E-03	2.11E-07	4.91E-09	2.50E-07	1.14E-08	1.46E-07
150	1.32E-03	4.49E-07	4.25E-05	2.65E-09	6.17E-11	5.73E-07	1.44E-10	2.11E-07
250	2.13E-07	9.98E-08	0.00E+00	0.00E+00	0.00E+00	7.77E-07	2.04E-19	1.66E-07
500	2.04E-09	2.23E-07	0.00E+00	0.00E+00	0.00E+00	3.74E-07	0.00E+00	4.89E-08
750	0.00E+00	1.56E-05	0.00E+00	0.00E+00	0.00E+00	1.72E-07	0.00E+00	2.51E-08
1000	0.00E+00	7.65E-05	0.00E+00	0.00E+00	0.00E+00	1.28E-07	0.00E+00	4.08E-08
2000	0.00E+00	9.36E-05	0.00E+00	0.00E+00	0.00E+00	5.37E-06	0.00E+00	5.09E-06

Capped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	2.20E-21	0.00E+00	8.63E-06	1.84E-07	2.49E-10	0.00E+00	4.82E-17	0.00E+00
2	2.42E-04	0.00E+00	1.51E-03	6.45E-05	7.93E-07	0.00E+00	2.14E-06	0.00E+00
4	1.48E-03	6.21E-31	2.64E-03	6.31E-05	8.00E-07	0.00E+00	4.24E-06	0.00E+00
6	1.74E-03	6.48E-24	8.06E-02	6.26E-05	8.11E-07	4.87E-39	4.33E-06	3.79E-36
8	1.76E-03	1.73E-19	5.10E-01	6.10E-05	8.30E-07	3.96E-35	4.30E-06	6.77E-30
10	1.72E-03	2.48E-16	1.19E+00	5.92E-05	8.33E-07	8.94E-30	4.24E-06	7.61E-26
20	1.90E-03	1.85E-10	2.60E+00	5.12E-05	7.33E-07	8.92E-20	3.86E-06	1.29E-16
30	3.14E-03	1.17E-08	2.33E+00	4.42E-05	6.33E-07	1.31E-14	3.40E-06	8.52E-13
40	2.76E-02	8.27E-08	2.02E+00	3.82E-05	5.47E-07	4.71E-12	2.98E-06	6.25E-11
50	1.38E-01	2.36E-07	1.74E+00	3.30E-05	4.73E-07	1.52E-10	2.58E-06	7.55E-10
60	3.47E-01	4.40E-07	1.50E+00	2.85E-05	4.08E-07	1.54E-09	2.23E-06	4.02E-09
70	6.24E-01	6.27E-07	1.30E+00	2.46E-05	3.53E-07	7.15E-09	1.92E-06	1.24E-08
80	9.05E-01	7.66E-07	1.12E+00	2.12E-05	3.04E-07	2.28E-08	1.66E-06	2.77E-08
100	1.31E+00	9.61E-07	8.36E-01	1.58E-05	2.27E-07	1.07E-07	1.24E-06	7.88E-08
150	1.37E+00	9.45E-07	4.02E-01	7.61E-06	1.09E-07	6.41E-07	5.95E-07	2.05E-07
250	4.55E-01	3.59E-07	9.29E-02	1.76E-06	2.52E-08	9.95E-07	1.38E-07	2.23E-07
500	1.32E-02	1.51E-08	2.38E-03	4.51E-08	6.47E-10	4.60E-07	3.53E-09	5.89E-08
750	3.46E-04	1.55E-09	6.11E-05	1.16E-09	1.66E-11	8.47E-08	9.05E-11	7.57E-09
1000	8.88E-06	3.02E-09	1.56E-06	2.95E-11	4.23E-13	1.49E-08	2.31E-12	1.91E-09
2000	0.00E+00	7.86E-06	0.00E+00	0.00E+00	0.00E+00	8.89E-10	0.00E+00	5.69E-10

Uncapped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	2.76E-11	0.00E+00	6.27E-04	2.61E-05	1.64E-07	0.00E+00	8.36E-09	0.00E+00
2	5.73E-03	1.17E-29	1.51E-02	6.29E-04	1.02E-05	7.80E-35	6.19E-05	4.66E-24
4	1.09E-02	1.20E-16	7.34E+00	5.24E-03	1.60E-04	1.62E-21	8.32E-05	2.55E-12
6	1.17E-02	6.39E-12	1.58E+01	5.28E-03	3.80E-04	1.72E-14	7.93E-04	2.68E-09
8	5.85E-02	6.97E-10	1.88E+01	4.45E-03	3.89E-04	1.48E-11	3.03E-03	5.02E-08
10	4.35E-01	9.66E-09	1.88E+01	3.74E-03	3.27E-04	6.25E-10	3.94E-03	2.35E-07
20	7.64E+00	9.13E-07	9.95E+00	1.56E-03	1.36E-04	5.48E-07	2.63E-03	1.57E-06
30	9.19E+00	2.66E-06	4.22E+00	6.49E-04	5.68E-05	3.21E-06	1.10E-03	1.77E-06
40	8.27E+00	3.72E-06	1.76E+00	2.71E-04	2.37E-05	5.27E-06	4.57E-04	1.60E-06
50	7.28E+00	4.07E-06	7.35E-01	1.13E-04	9.86E-06	5.92E-06	1.90E-04	1.49E-06
60	6.07E+00	3.87E-06	3.07E-01	4.70E-05	4.11E-06	5.96E-06	7.94E-05	1.32E-06
70	5.31E+00	3.60E-06	1.28E-01	1.96E-05	1.71E-06	5.83E-06	3.31E-05	1.30E-06
80	4.08E+00	3.32E-06	5.33E-02	8.17E-06	7.15E-07	5.42E-06	1.38E-05	1.26E-06
100	2.11E+00	2.81E-06	9.26E-03	1.42E-06	1.24E-07	4.96E-06	2.40E-06	1.14E-06
150	1.86E-01	1.91E-06	1.17E-04	1.79E-08	1.56E-09	3.97E-06	3.02E-08	9.15E-06
250	5.97E-04	6.22E-06	0.00E+00	0.00E+00	0.00E+00	3.32E-06	7.77E-13	1.66E-04
500	9.12E-09	4.40E-04	0.00E+00	0.00E+00	0.00E+00	3.03E-04	0.00E+00	1.95E-04
750	5.41E-09	6.33E-04	0.00E+00	0.00E+00	0.00E+00	7.63E-04	0.00E+00	1.70E-04
1000	0.00E+00	5.77E-04	0.00E+00	0.00E+00	0.00E+00	7.89E-04	0.00E+00	1.65E-04
2000	0.00E+00	3.28E-04	0.00E+00	0.00E+00	0.00E+00	5.63E-04	0.00E+00	9.42E-05

Capped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	1.18E-11	0.00E+00	1.60E-04	6.40E-06	3.85E-08	0.00E+00	2.33E-09	0.00E+00
2	1.35E-03	1.97E-30	3.96E-03	1.66E-04	2.54E-06	2.93E-35	1.44E-05	3.59E-24
4	3.10E-03	1.85E-17	7.80E-03	1.63E-04	2.64E-06	3.28E-23	1.87E-05	1.60E-12
6	3.68E-03	1.04E-12	2.86E-01	1.60E-04	2.77E-06	2.34E-16	1.84E-05	1.11E-09
8	3.90E-03	1.14E-10	1.21E+00	1.56E-04	3.39E-06	5.30E-13	1.84E-05	1.46E-08
10	3.90E-03	1.67E-09	2.57E+00	1.52E-04	4.19E-06	3.99E-11	2.00E-05	5.06E-08
20	1.78E-02	2.25E-07	6.83E+00	1.31E-04	3.83E-06	9.66E-08	3.63E-05	5.15E-07
30	3.16E-01	8.89E-07	6.33E+00	1.13E-04	3.31E-06	7.69E-07	3.61E-05	8.88E-07
40	1.02E+00	1.59E-06	5.49E+00	9.79E-05	2.85E-06	2.15E-06	3.12E-05	9.85E-07
50	1.89E+00	2.08E-06	4.74E+00	8.46E-05	2.47E-06	3.26E-06	2.70E-05	1.04E-06
60	2.53E+00	2.50E-06	4.10E+00	7.30E-05	2.13E-06	3.94E-06	2.33E-05	1.09E-06
70	3.08E+00	2.76E-06	3.54E+00	6.31E-05	1.84E-06	4.84E-06	2.01E-05	1.09E-06
80	3.39E+00	2.90E-06	3.06E+00	5.45E-05	1.59E-06	4.87E-06	1.74E-05	1.05E-06
100	3.63E+00	3.00E-06	2.28E+00	4.07E-05	1.19E-06	5.33E-06	1.30E-05	9.87E-07
150	3.27E+00	2.70E-06	1.10E+00	1.95E-05	5.70E-07	5.11E-06	6.23E-06	9.47E-07
250	1.63E+00	1.89E-06	2.53E-01	4.51E-06	1.32E-07	4.11E-06	1.44E-06	8.48E-07
500	6.38E-02	4.00E-07	6.49E-03	1.16E-07	3.38E-09	2.63E-06	3.69E-08	2.21E-05
750	1.68E-03	6.52E-06	1.67E-04	2.97E-09	8.66E-11	2.60E-06	9.47E-10	5.55E-05
1000	4.34E-05	4.85E-05	4.25E-06	7.57E-11	2.21E-12	1.44E-05	2.42E-11	8.69E-05
2000	2.25E-09	2.93E-04	0.00E+00	0.00E+00	0.00E+00	3.54E-04	0.00E+00	8.92E-05

Overburden at the River Morell

Uncapped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	6.14E-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	6.12E-33	0.00E+00	9.87E-09	9.38E-12	9.29E-16	0.00E+00	1.62E-27	0.00E+00
4	2.55E-16	0.00E+00	2.40E-03	1.47E-07	3.64E-10	0.00E+00	5.68E-15	0.00E+00
6	1.47E-10	0.00E+00	2.67E-01	1.78E-06	6.83E-09	0.00E+00	1.09E-11	0.00E+00
8	4.47E-08	0.00E+00	1.57E+00	2.36E-06	3.55E-08	0.00E+00	2.07E-10	0.00E+00
10	1.11E-06	0.00E+00	3.40E+00	2.06E-06	5.49E-08	0.00E+00	9.32E-10	0.00E+00
20	7.85E-04	0.00E+00	5.30E+00	8.58E-07	3.71E-08	0.00E+00	1.08E-08	0.00E+00
30	6.73E-02	0.00E+00	2.83E+00	3.58E-07	1.55E-08	0.00E+00	1.18E-08	0.00E+00
40	5.32E-01	1.53E-38	1.25E+00	1.49E-07	6.46E-09	0.00E+00	5.64E-09	0.00E+00
50	1.26E+00	2.35E-36	5.29E-01	6.22E-08	2.69E-09	0.00E+00	2.41E-09	0.00E+00
60	1.74E+00	3.99E-34	2.21E-01	2.59E-08	1.12E-09	0.00E+00	1.02E-09	0.00E+00
70	1.84E+00	1.78E-30	9.23E-02	1.08E-08	4.68E-10	0.00E+00	4.25E-10	0.00E+00
80	1.68E+00	1.33E-29	3.85E-02	4.50E-09	1.95E-10	0.00E+00	1.77E-10	5.23E-39
100	1.26E+00	2.56E-25	6.69E-03	7.83E-10	3.39E-11	7.58E-41	3.08E-11	2.25E-35
150	2.49E-01	4.12E-20	8.42E-05	9.85E-12	4.27E-13	9.28E-35	3.87E-13	1.90E-30
250	2.82E-03	5.01E-14	6.09E-09	0.00E+00	0.00E+00	7.80E-27	2.56E-17	4.59E-23
500	4.02E-08	9.52E-10	0.00E+00	0.00E+00	0.00E+00	1.66E-16	0.00E+00	3.82E-14
750	2.91E-09	1.64E-08	0.00E+00	0.00E+00	0.00E+00	9.65E-13	0.00E+00	1.94E-11
1000	8.73E-10	1.74E-07	0.00E+00	0.00E+00	0.00E+00	6.08E-11	0.00E+00	2.82E-10
2000	0.00E+00	3.71E-05	0.00E+00	0.00E+00	0.00E+00	1.69E-08	0.00E+00	2.43E-08

Capped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	2.05E-33	0.00E+00	4.08E-09	5.40E-12	7.00E-16	0.00E+00	1.14E-28	0.00E+00
4	5.40E-17	0.00E+00	7.07E-05	2.41E-08	7.95E-11	0.00E+00	5.18E-15	0.00E+00
6	2.98E-11	0.00E+00	8.42E-04	3.93E-08	4.13E-10	0.00E+00	6.35E-12	0.00E+00
8	9.49E-09	0.00E+00	1.67E-02	4.11E-08	5.86E-10	0.00E+00	1.06E-10	0.00E+00
10	2.44E-07	0.00E+00	1.20E-01	4.06E-08	6.59E-10	0.00E+00	3.79E-10	0.00E+00
20	8.23E-05	0.00E+00	1.78E+00	3.51E-08	6.52E-10	0.00E+00	1.56E-09	0.00E+00
30	4.08E-04	0.00E+00	2.37E+00	3.03E-08	5.69E-10	0.00E+00	1.46E-09	0.00E+00
40	9.98E-04	0.00E+00	2.18E+00	2.62E-08	4.91E-10	0.00E+00	1.32E-09	0.00E+00
50	3.59E-03	9.63E-39	1.91E+00	2.26E-08	4.24E-10	0.00E+00	1.14E-09	0.00E+00
60	1.97E-02	2.27E-35	1.66E+00	1.95E-08	3.67E-10	0.00E+00	9.85E-10	0.00E+00
70	6.92E-02	8.20E-31	1.43E+00	1.69E-08	3.17E-10	0.00E+00	8.51E-10	0.00E+00
80	1.70E-01	2.13E-28	1.24E+00	1.46E-08	2.74E-10	0.00E+00	7.35E-10	1.39E-40
100	5.04E-01	1.61E-25	9.23E-01	1.09E-08	2.04E-10	0.00E+00	5.48E-10	8.43E-37
150	1.11E+00	4.07E-20	4.44E-01	5.23E-09	9.81E-11	1.17E-35	2.64E-10	1.46E-30
250	7.25E-01	4.23E-14	1.03E-01	1.21E-09	2.27E-11	3.50E-26	6.09E-11	4.58E-24
500	2.60E-02	8.48E-10	2.63E-03	3.10E-11	5.81E-13	1.85E-17	1.56E-12	6.53E-15
750	6.80E-04	1.62E-08	6.75E-05	7.95E-13	1.49E-14	2.68E-13	4.01E-14	6.40E-12
1000	1.75E-05	5.00E-08	1.72E-06	2.03E-14	3.80E-16	2.81E-11	1.02E-15	1.68E-10
2000	8.12E-10	2.03E-07	0.00E+00	0.00E+00	0.00E+00	1.49E-08	0.00E+00	9.19E-09

Uncapped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	2.16E-27	2.74E-30	3.04E-35	0.00E+00	0.00E+00	0.00E+00
2	2.62E-20	0.00E+00	7.98E-06	3.15E-08	1.02E-10	0.00E+00	1.03E-13	0.00E+00
4	1.75E-08	0.00E+00	1.56E-01	2.88E-05	3.20E-07	0.00E+00	3.48E-08	0.00E+00
6	7.43E-06	0.00E+00	2.86E+00	8.47E-05	6.61E-06	0.00E+00	1.07E-06	0.00E+00
8	9.56E-05	0.00E+00	7.30E+00	8.04E-05	1.41E-05	0.00E+00	1.79E-05	0.00E+00
10	5.55E-04	0.00E+00	1.01E+01	6.76E-05	1.64E-05	0.00E+00	8.64E-05	1.42E-36
20	5.53E-01	7.10E-32	1.27E+01	2.82E-05	7.47E-06	4.46E-39	2.54E-04	9.12E-26
30	3.03E+00	6.18E-27	9.17E+00	1.18E-05	3.12E-06	8.92E-34	1.16E-04	1.01E-22
40	4.83E+00	9.27E-24	4.85E+00	4.90E-06	1.30E-06	3.90E-29	5.15E-05	7.55E-18
50	5.02E+00	2.84E-21	2.43E+00	2.04E-06	5.41E-07	2.04E-26	2.15E-05	3.13E-15
60	4.97E+00	1.74E-18	1.06E+00	8.51E-07	2.26E-07	2.41E-23	8.98E-06	1.63E-13
70	4.53E+00	1.63E-16	4.69E-01	3.55E-07	9.41E-08	3.32E-21	3.74E-06	2.63E-12
80	4.07E+00	4.95E-15	2.02E-01	1.48E-07	3.92E-08	5.86E-19	1.56E-06	2.04E-11
100	3.46E+00	5.46E-13	3.70E-02	2.57E-08	6.81E-09	5.96E-16	2.71E-07	4.12E-10
150	2.17E+00	2.20E-10	4.66E-04	3.23E-10	8.58E-11	4.34E-12	3.41E-09	1.61E-08
250	5.06E-01	1.84E-08	8.31E-08	0.00E+00	9.37E-18	3.33E-09	3.57E-13	1.13E-06
500	3.87E-03	5.39E-06	0.00E+00	0.00E+00	0.00E+00	5.01E-07	2.04E-18	8.75E-05
750	3.20E-05	8.28E-05	0.00E+00	0.00E+00	0.00E+00	2.54E-05	0.00E+00	1.10E-04
1000	2.57E-07	2.05E-04	0.00E+00	0.00E+00	0.00E+00	1.66E-04	0.00E+00	9.73E-05
2000	2.87E-10	2.53E-04	0.00E+00	0.00E+00	0.00E+00	3.57E-04	0.00E+00	7.44E-05

Capped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	5.07E-28	6.57E-31	7.45E-36	0.00E+00	0.00E+00	0.00E+00
2	7.48E-21	0.00E+00	2.42E-06	8.53E-09	2.97E-11	0.00E+00	2.87E-14	0.00E+00
4	5.44E-09	0.00E+00	4.94E-04	4.78E-07	1.33E-08	0.00E+00	8.92E-09	0.00E+00
6	1.95E-06	0.00E+00	1.06E-02	5.65E-07	3.41E-08	0.00E+00	1.19E-07	0.00E+00
8	2.40E-05	0.00E+00	1.46E-01	6.13E-07	5.60E-08	0.00E+00	2.69E-07	0.00E+00
10	8.92E-05	0.00E+00	5.68E-01	6.05E-07	1.02E-07	0.00E+00	3.79E-07	2.89E-38
20	9.68E-04	2.68E-34	3.89E+00	5.23E-07	1.54E-07	3.22E-38	1.80E-06	6.40E-28
30	1.71E-02	9.74E-28	5.77E+00	4.52E-07	1.33E-07	1.04E-31	2.52E-06	3.80E-22
40	1.56E-01	1.96E-24	5.99E+00	3.90E-07	1.15E-07	6.63E-28	2.32E-06	6.82E-18
50	5.23E-01	3.72E-22	5.49E+00	3.37E-07	9.95E-08	1.34E-25	2.02E-06	2.53E-15
60	1.03E+00	2.92E-19	4.81E+00	2.91E-07	8.59E-08	1.09E-24	1.74E-06	1.27E-13
70	1.57E+00	2.92E-17	4.20E+00	2.52E-07	7.42E-08	3.95E-23	1.50E-06	2.04E-12
80	1.98E+00	9.98E-16	3.63E+00	2.17E-07	6.41E-08	2.64E-21	1.30E-06	1.61E-11
100	2.62E+00	1.16E-13	2.71E+00	1.62E-07	4.78E-08	6.22E-18	9.69E-07	2.78E-10
150	2.89E+00	6.03E-11	1.30E+00	7.79E-08	2.30E-08	2.09E-13	4.66E-07	8.95E-09
250	2.30E+00	8.27E-09	3.01E-01	1.80E-08	5.31E-09	6.76E-10	1.08E-07	8.39E-08
500	2.89E-01	1.70E-07	7.72E-03	4.62E-10	1.36E-10	1.20E-07	2.76E-09	7.60E-07
750	9.99E-03	3.25E-07	1.98E-04	1.19E-11	3.49E-12	4.39E-07	7.09E-11	1.10E-05
1000	2.83E-04	1.92E-06	5.06E-06	3.02E-13	8.91E-14	7.24E-07	1.81E-12	2.21E-05
2000	2.73E-09	1.22E-04	0.00E+00	0.00E+00	0.00E+00	7.07E-05	0.00E+00	7.18E-05

Limestone Aquifer

Uncapped 50 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	2.65E-31	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	5.36E-04	2.01E-08	2.14E-16	0.00E+00	0.00E+00	0.00E+00
4	2.43E-31	0.00E+00	3.75E-01	2.13E-06	3.90E-10	0.00E+00	1.93E-24	0.00E+00
6	1.49E-21	0.00E+00	3.74E+00	3.87E-06	2.03E-09	0.00E+00	1.32E-17	0.00E+00
8	7.67E-17	0.00E+00	5.73E+00	4.19E-06	2.74E-09	0.00E+00	9.91E-15	0.00E+00
10	3.18E-13	0.00E+00	6.22E+00	3.59E-06	2.55E-09	0.00E+00	3.30E-13	0.00E+00
20	8.74E-07	0.00E+00	3.75E+00	1.50E-06	1.30E-09	0.00E+00	1.69E-11	0.00E+00
30	4.44E-05	0.00E+00	1.74E+00	6.24E-07	5.42E-10	0.00E+00	1.59E-11	0.00E+00
40	2.35E-04	0.00E+00	7.45E-01	2.60E-07	2.26E-10	0.00E+00	7.97E-12	0.00E+00
50	5.87E-04	0.00E+00	3.13E-01	1.09E-07	9.42E-11	0.00E+00	3.49E-12	0.00E+00
60	1.36E-03	0.00E+00	1.31E-01	4.52E-08	3.93E-11	0.00E+00	1.51E-12	0.00E+00
70	4.37E-03	0.00E+00	5.46E-02	1.89E-08	1.64E-11	0.00E+00	6.28E-13	0.00E+00
80	1.47E-02	0.00E+00	2.28E-02	7.86E-09	6.83E-12	0.00E+00	2.62E-13	0.00E+00
100	7.90E-02	0.00E+00	3.96E-03	1.37E-09	1.19E-12	0.00E+00	4.55E-14	0.00E+00
150	3.42E-01	1.09E-37	4.98E-05	1.72E-11	1.49E-14	0.00E+00	5.73E-16	0.00E+00
250	2.73E-01	2.61E-27	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.05E-20	2.14E-38
500	4.67E-02	5.56E-17	0.00E+00	0.00E+00	0.00E+00	1.78E-33	1.55E-39	1.82E-26
750	3.45E-03	7.34E-13	0.00E+00	0.00E+00	0.00E+00	1.49E-24	0.00E+00	5.21E-21
1000	2.27E-04	5.04E-11	0.00E+00	0.00E+00	0.00E+00	1.28E-21	0.00E+00	5.57E-17
2000	4.22E-09	1.07E-08	0.00E+00	0.00E+00	0.00E+00	5.66E-13	0.00E+00	2.11E-11

Capped 50 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.47E-31	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	1.22E-04	4.15E-09	1.89E-17	0.00E+00	0.00E+00	0.00E+00
4	3.84E-34	0.00E+00	1.30E-03	5.01E-07	6.31E-11	0.00E+00	2.67E-25	0.00E+00
6	3.07E-22	0.00E+00	1.84E-02	5.40E-07	4.46E-10	0.00E+00	4.17E-19	0.00E+00
8	2.18E-17	0.00E+00	2.09E-01	5.26E-07	6.42E-10	0.00E+00	5.95E-16	0.00E+00
10	7.09E-14	0.00E+00	6.39E-01	5.12E-07	7.03E-10	0.00E+00	2.44E-14	0.00E+00
20	1.88E-07	0.00E+00	2.11E+00	4.43E-07	6.31E-10	0.00E+00	3.41E-12	0.00E+00
30	1.39E-05	0.00E+00	2.13E+00	3.82E-07	5.45E-10	0.00E+00	6.47E-12	0.00E+00
40	8.98E-05	0.00E+00	1.91E+00	3.30E-07	4.70E-10	0.00E+00	6.23E-12	0.00E+00
50	2.28E-04	0.00E+00	1.67E+00	2.85E-07	4.06E-10	0.00E+00	6.01E-12	0.00E+00
60	3.82E-04	0.00E+00	1.44E+00	2.46E-07	3.51E-10	0.00E+00	5.19E-12	0.00E+00
70	5.77E-04	0.00E+00	1.25E+00	2.13E-07	3.03E-10	0.00E+00	4.48E-12	0.00E+00
80	7.51E-04	0.00E+00	1.08E+00	1.84E-07	2.62E-10	0.00E+00	3.87E-12	0.00E+00
100	1.61E-03	0.00E+00	8.06E-01	1.37E-07	1.95E-10	0.00E+00	2.89E-12	0.00E+00
150	4.48E-02	0.00E+00	3.89E-01	6.59E-08	9.39E-11	0.00E+00	1.39E-12	0.00E+00
250	4.72E-01	2.29E-29	9.02E-02	1.52E-08	2.17E-11	0.00E+00	3.21E-13	0.00E+00
500	2.25E-01	2.62E-17	2.32E-03	3.90E-10	5.56E-13	2.68E-35	8.23E-15	1.66E-27
750	3.47E-02	4.63E-13	5.94E-05	1.00E-11	1.43E-14	1.39E-25	2.11E-16	4.46E-22
1000	2.79E-03	4.24E-11	1.52E-06	2.55E-13	3.64E-16	1.00E-21	5.38E-18	1.60E-17
2000	3.82E-08	1.38E-08	0.00E+00	0.00E+00	0.00E+00	5.49E-13	0.00E+00	1.40E-11

Uncapped 95 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.87E-14	2.89E-24	7.57E-34	0.00E+00	0.00E+00	0.00E+00
2	8.17E-26	0.00E+00	2.40E-02	2.23E-05	7.51E-09	0.00E+00	2.10E-20	0.00E+00
4	4.61E-14	0.00E+00	1.01E+01	5.08E-04	5.95E-07	0.00E+00	5.20E-10	0.00E+00
6	9.07E-09	0.00E+00	1.66E+01	8.03E-04	3.57E-06	0.00E+00	3.79E-08	0.00E+00
8	1.21E-06	0.00E+00	1.75E+01	6.93E-04	8.45E-06	0.00E+00	1.95E-07	0.00E+00
10	1.81E-05	0.00E+00	1.66E+01	5.82E-04	1.06E-05	0.00E+00	3.95E-07	0.00E+00
20	1.36E-03	0.00E+00	1.01E+01	2.43E-04	4.67E-06	0.00E+00	7.80E-07	0.00E+00
30	1.87E-02	2.31E-36	5.43E+00	1.01E-04	1.95E-06	0.00E+00	9.09E-07	5.13E-34
40	2.24E-01	1.47E-33	2.77E+00	4.22E-05	8.12E-07	1.95E-39	4.43E-07	8.97E-30
50	7.45E-01	2.90E-29	1.25E+00	1.76E-05	3.38E-07	2.89E-37	1.86E-07	1.51E-26
60	1.41E+00	1.35E-28	5.61E-01	7.33E-06	1.41E-07	6.48E-37	7.75E-08	3.76E-24
70	1.93E+00	1.64E-26	2.64E-01	3.06E-06	5.88E-08	7.62E-33	3.23E-08	9.48E-23
80	2.31E+00	2.51E-24	1.12E-01	1.27E-06	2.45E-08	9.21E-33	1.35E-08	4.11E-21
100	2.45E+00	2.79E-23	2.10E-02	2.21E-07	4.26E-09	6.69E-29	2.34E-09	1.55E-17
150	1.79E+00	1.04E-16	2.64E-04	2.78E-09	5.36E-11	2.12E-23	2.95E-11	5.04E-13
250	1.07E+00	9.79E-12	4.56E-08	0.00E+00	2.43E-17	1.73E-16	5.02E-15	1.24E-09
500	4.70E-01	1.56E-08	0.00E+00	0.00E+00	0.00E+00	2.89E-10	2.52E-18	4.77E-08
750	2.49E-01	8.49E-08	0.00E+00	0.00E+00	0.00E+00	1.67E-08	1.15E-22	3.40E-07
1000	1.29E-01	2.17E-07	0.00E+00	0.00E+00	0.00E+00	6.73E-08	0.00E+00	4.55E-06
2000	1.11E-02	2.75E-05	0.00E+00	0.00E+00	0.00E+00	1.61E-06	0.00E+00	2.67E-05

Capped 95 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	5.05E-15	1.01E-24	6.33E-34	0.00E+00	0.00E+00	0.00E+00
2	1.05E-26	0.00E+00	1.72E-03	5.17E-06	2.36E-09	0.00E+00	4.74E-20	0.00E+00
4	8.45E-15	0.00E+00	1.68E-02	1.25E-05	1.30E-07	0.00E+00	3.78E-10	0.00E+00
6	1.61E-09	0.00E+00	4.99E-01	1.24E-05	1.62E-07	0.00E+00	1.80E-08	0.00E+00
8	2.81E-07	0.00E+00	1.83E+00	1.23E-05	1.69E-07	0.00E+00	7.48E-08	0.00E+00
10	3.87E-06	0.00E+00	3.21E+00	1.20E-05	1.69E-07	0.00E+00	1.17E-07	0.00E+00
20	3.89E-04	0.00E+00	5.78E+00	1.03E-05	1.61E-07	0.00E+00	2.07E-07	0.00E+00
30	1.02E-03	3.63E-40	5.56E+00	8.92E-06	1.39E-07	0.00E+00	1.93E-07	7.69E-35
40	2.11E-03	1.05E-35	5.09E+00	7.70E-06	1.20E-07	0.00E+00	1.67E-07	5.54E-30
50	7.85E-03	2.74E-33	4.43E+00	6.65E-06	1.04E-07	9.61E-40	1.44E-07	1.32E-26
60	4.25E-02	1.70E-29	3.82E+00	5.74E-06	8.97E-08	4.42E-36	1.25E-07	1.48E-25
70	1.40E-01	4.64E-29	3.35E+00	4.96E-06	7.74E-08	1.91E-35	1.08E-07	6.61E-23
80	3.45E-01	2.57E-26	2.91E+00	4.29E-06	6.69E-08	1.77E-32	9.29E-08	1.11E-20
100	7.89E-01	3.90E-24	2.20E+00	3.20E-06	4.99E-08	5.82E-29	6.93E-08	2.35E-17
150	1.66E+00	5.85E-19	1.06E+00	1.54E-06	2.40E-08	1.84E-24	3.33E-08	5.20E-13
250	1.72E+00	3.57E-13	2.45E-01	3.55E-07	5.54E-09	1.08E-16	7.70E-09	8.79E-10
500	9.22E-01	4.59E-09	6.35E-03	9.11E-09	1.42E-10	2.41E-10	1.98E-10	6.63E-08
750	4.92E-01	5.29E-08	1.63E-04	2.34E-10	3.65E-12	1.58E-08	5.07E-12	1.06E-07
1000	2.63E-01	1.10E-07	4.16E-06	5.96E-12	9.30E-14	8.95E-08	1.29E-13	1.36E-07
2000	2.77E-02	2.92E-07	0.00E+00	0.00E+00	0.00E+00	3.35E-07	0.00E+00	4.68E-06

Appendix C. Zone 2B specific input parameters and results

LANDFILL WASTE:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Distribution		triangular	triangular	triangular	triangular	triangular	triangular	triangular	triangular
Landfill waste leaching test concentration Minimum	mg/L	0.05	0.0025	0.47	0.0001	0.001	0.003	0.001	0.0025
Landfill waste leaching test concentration Likely	mg/L	50	0.044	27	0.1	0.011	0.127	0.03	0.039
Landfill waste leaching test concentration Maximum	mg/L	100	0.224	99	10	0.14	0.605	1	0.078

DIMENSIONS OF ZONE:

Parameter	Units	Saturated Waste	Unsaturated Waste	Total for Zone
Width (perpendicular to groundwater flow)	m	200	Assumed there is no unsaturated waste	200
Length (in direction of groundwater flow)	m	150		150
Area	m^2	30,000		30,000
Waste thickness	m	1.5		-

CONTAMINANTS:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Contaminants Organic Carbon Water Partition Coefficient, Koc	L/kg	-	-	-	3.60E+00	1.29E+01	-	8.32E+01	-
Attenuation partition coefficient Kd Distribution		uniform	uniform	constant	-	-	uniform	-	uniform

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Attenuation partition coefficient Kd Minimum	L/kg	0.5	25	0	-	-	20	-	1
Attenuation partition coefficient Kd Maximum	L/kg	2	125	-	-	-	400	-	300
Attenuation half-life distribution		constant	constant	constant	constant	uniform	constant	uniform	constant
Attenuation half-life Minimum	days	No Decay	No Decay	No Decay	139.8	50.01	No Decay	7.3	No Decay
Attenuation half-life Maximum	days	-	-	-	-	365	-	912.5	-
Contaminants free water diffusion coefficient	m^2/s	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09

HYDROGEOLOGY:

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology unit thickness distribution		uniform	constant	constant
Hydrogeology unit thickness Minimum	m	10	20	0.1
Hydrogeology unit thickness Maximum	m	13		
Hydrogeology hydraulic conductivity distribution		triangular	triangular	triangular
Hydrogeology hydraulic conductivity Minimum	m/s	2.31E-06	3.25E-08	2.31E-06
Hydrogeology hydraulic conductivity Likely	m/s	6.60E-06	0.0000128	6.60E-06
Hydrogeology hydraulic conductivity Maximum	m/s	1.56E-05	0.0000625	1.56E-05

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology head	m	81	78	-
Hydrogeology hydraulic gradient distribution	[-]	uniform	uniform	constant
Hydrogeology hydraulic gradient Minimum		0.018	0.002	1
Hydrogeology hydraulic gradient Maximum		0.022	0.003	
Hydrogeology porosity distribution	[-]	uniform	uniform	constant
Hydrogeology porosity Minimum		0.31	0.01	0.2
Hydrogeology porosity Maximum		0.46	0.1	
Hydrogeology tortuosity	[-]	5	5	5
Distribution		constant	constant	constant

ATTENUATION

Parameter	Units	Sand and Gravel	Limestone	Unsat SandG
Attenuation dry bulk density	kg/m3	1590	2265	1590
Attenuation fraction organic carbon distribution		triangular	uniform	triangular
Attenuation fraction organic carbon Minimum	[-]	0.001	0.001	0.001
Attenuation fraction organic carbon Likely	[-]	0.002		0.002
Attenuation fraction organic carbon Maximum	[-]	0.024	0.016	0.024

MODEL RESULTS

Saturated Waste

Uncapped 50 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	4.49E+01	7.72E-02	3.57E+01	2.59E+00	4.16E-02	1.94E-01	2.75E-01	3.57E-02
2	4.06E+01	6.98E-02	3.23E+01	2.34E+00	3.77E-02	1.76E-01	2.49E-01	3.23E-02
4	3.32E+01	5.72E-02	2.64E+01	1.92E+00	3.08E-02	1.44E-01	2.04E-01	2.65E-02
6	2.72E+01	4.68E-02	2.17E+01	1.57E+00	2.52E-02	1.18E-01	1.67E-01	2.17E-02
8	2.23E+01	3.83E-02	1.77E+01	1.29E+00	2.07E-02	9.63E-02	1.37E-01	1.77E-02
10	1.82E+01	3.14E-02	1.45E+01	1.05E+00	1.69E-02	7.89E-02	1.12E-01	1.45E-02
20	6.71E+00	1.15E-02	5.34E+00	3.88E-01	6.23E-03	2.90E-02	4.12E-02	5.35E-03
30	2.47E+00	4.25E-03	1.96E+00	1.43E-01	2.29E-03	1.07E-02	1.51E-02	1.97E-03
40	9.08E-01	1.56E-03	7.23E-01	5.24E-02	8.42E-04	3.93E-03	5.57E-03	7.23E-04
50	3.34E-01	5.75E-04	2.66E-01	1.93E-02	3.10E-04	1.44E-03	2.05E-03	2.66E-04
60	1.23E-01	2.11E-04	9.78E-02	7.10E-03	1.14E-04	5.31E-04	7.54E-04	9.79E-05
70	4.52E-02	7.78E-05	3.60E-02	2.61E-03	4.19E-05	1.96E-04	2.77E-04	3.60E-05
80	1.66E-02	2.86E-05	1.32E-02	9.61E-04	1.54E-05	7.19E-05	1.02E-04	1.32E-05
100	2.25E-03	3.87E-06	1.79E-03	1.30E-04	2.09E-06	9.73E-06	1.38E-05	1.79E-06
150	1.50E-05	2.59E-08	1.20E-05	8.68E-07	1.40E-08	6.50E-08	9.23E-08	1.20E-08
250	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Capped 50 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	4.64E+01	7.71E-02	3.59E+01	2.63E+00	4.20E-02	2.12E-01	2.97E-01	3.61E-02
2	4.57E+01	7.58E-02	3.53E+01	2.58E+00	4.13E-02	2.08E-01	2.93E-01	3.55E-02
4	4.41E+01	7.33E-02	3.42E+01	2.50E+00	4.00E-02	2.02E-01	2.83E-01	3.44E-02
6	4.27E+01	7.09E-02	3.31E+01	2.42E+00	3.86E-02	1.95E-01	2.74E-01	3.32E-02
8	4.13E+01	6.86E-02	3.20E+01	2.34E+00	3.74E-02	1.89E-01	2.65E-01	3.21E-02
10	3.99E+01	6.63E-02	3.09E+01	2.26E+00	3.61E-02	1.82E-01	2.56E-01	3.11E-02
20	3.38E+01	5.61E-02	2.61E+01	1.91E+00	3.06E-02	1.54E-01	2.16E-01	2.63E-02
30	2.86E+01	4.74E-02	2.21E+01	1.62E+00	2.59E-02	1.30E-01	1.83E-01	2.22E-02
40	2.42E+01	4.01E-02	1.87E+01	1.37E+00	2.19E-02	1.10E-01	1.55E-01	1.88E-02
50	2.04E+01	3.39E-02	1.58E+01	1.16E+00	1.85E-02	9.33E-02	1.31E-01	1.59E-02
60	1.73E+01	2.87E-02	1.34E+01	9.78E-01	1.56E-02	7.89E-02	1.11E-01	1.35E-02
70	1.46E+01	2.43E-02	1.13E+01	8.28E-01	1.32E-02	6.68E-02	9.37E-02	1.14E-02
80	1.24E+01	2.05E-02	9.57E+00	7.00E-01	1.12E-02	5.65E-02	7.92E-02	9.63E-03
100	8.85E+00	1.47E-02	6.85E+00	5.01E-01	8.01E-03	4.04E-02	5.67E-02	6.89E-03
150	3.83E+00	6.36E-03	2.97E+00	2.17E-01	3.47E-03	1.75E-02	2.45E-02	2.98E-03
250	7.18E-01	1.19E-03	5.56E-01	4.06E-02	6.50E-04	3.28E-03	4.60E-03	5.59E-04
500	1.09E-02	1.81E-05	8.45E-03	6.18E-04	9.88E-06	4.98E-05	6.99E-05	8.50E-06
750	1.66E-04	2.75E-07	1.28E-04	9.38E-06	1.50E-07	7.57E-07	1.06E-06	1.29E-07
1000	2.39E-06	3.98E-09	1.85E-06	1.36E-07	2.17E-09	1.09E-08	1.53E-08	1.86E-09
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Uncapped 95 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	7.58E+01	1.65E-01	7.37E+01	6.95E+00	1.01E-01	4.40E-01	7.08E-01	5.90E-02
2	6.86E+01	1.49E-01	6.67E+01	6.29E+00	9.15E-02	3.98E-01	6.40E-01	5.34E-02
4	5.62E+01	1.22E-01	5.46E+01	5.15E+00	7.49E-02	3.26E-01	5.24E-01	4.37E-02
6	4.60E+01	9.99E-02	4.47E+01	4.21E+00	6.13E-02	2.67E-01	4.29E-01	3.58E-02
8	3.77E+01	8.18E-02	3.66E+01	3.45E+00	5.02E-02	2.18E-01	3.51E-01	2.93E-02
10	3.08E+01	6.70E-02	3.00E+01	2.82E+00	4.11E-02	1.79E-01	2.88E-01	2.40E-02
20	1.13E+01	2.46E-02	1.10E+01	1.04E+00	1.51E-02	6.58E-02	1.06E-01	8.82E-03
30	4.17E+00	9.07E-03	4.06E+00	3.82E-01	5.56E-03	2.42E-02	3.89E-02	3.24E-03
40	1.54E+00	3.34E-03	1.49E+00	1.41E-01	2.05E-03	8.91E-03	1.43E-02	1.19E-03
50	5.65E-01	1.23E-03	5.49E-01	5.17E-02	7.53E-04	3.28E-03	5.27E-03	4.39E-04
60	2.08E-01	4.51E-04	2.02E-01	1.90E-02	2.77E-04	1.21E-03	1.94E-03	1.62E-04
70	7.64E-02	1.66E-04	7.43E-02	7.00E-03	1.02E-04	4.43E-04	7.13E-04	5.94E-05
80	2.81E-02	6.11E-05	2.73E-02	2.58E-03	3.75E-05	1.63E-04	2.62E-04	2.19E-05
100	3.81E-03	8.27E-06	3.70E-03	3.49E-04	5.07E-06	2.21E-05	3.55E-05	2.96E-06
150	2.54E-05	5.52E-08	2.47E-05	2.33E-06	3.39E-08	1.47E-07	2.37E-07	1.98E-08
250	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Capped 95 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	7.63E+01	1.60E-01	7.21E+01	7.16E+00	1.03E-01	4.38E-01	6.87E-01	5.85E-02
2	7.50E+01	1.58E-01	7.09E+01	7.04E+00	1.01E-01	4.31E-01	6.76E-01	5.76E-02
4	7.26E+01	1.53E-01	6.85E+01	6.81E+00	9.75E-02	4.17E-01	6.54E-01	5.57E-02
6	7.02E+01	1.48E-01	6.63E+01	6.58E+00	9.43E-02	4.03E-01	6.32E-01	5.38E-02
8	6.79E+01	1.43E-01	6.41E+01	6.37E+00	9.12E-02	3.90E-01	6.11E-01	5.21E-02
10	6.56E+01	1.38E-01	6.20E+01	6.16E+00	8.82E-02	3.77E-01	5.91E-01	5.04E-02
20	5.55E+01	1.17E-01	5.24E+01	5.21E+00	7.46E-02	3.19E-01	5.00E-01	4.26E-02
30	4.70E+01	9.87E-02	4.43E+01	4.40E+00	6.31E-02	2.70E-01	4.23E-01	3.60E-02
40	3.97E+01	8.35E-02	3.75E+01	3.73E+00	5.34E-02	2.28E-01	3.58E-01	3.05E-02
50	3.36E+01	7.06E-02	3.17E+01	3.15E+00	4.51E-02	1.93E-01	3.03E-01	2.58E-02
60	2.84E+01	5.97E-02	2.68E+01	2.67E+00	3.82E-02	1.63E-01	2.56E-01	2.18E-02
70	2.40E+01	5.05E-02	2.27E+01	2.25E+00	3.23E-02	1.38E-01	2.16E-01	1.84E-02
80	2.03E+01	4.27E-02	1.92E+01	1.91E+00	2.73E-02	1.17E-01	1.83E-01	1.56E-02
100	1.45E+01	3.06E-02	1.37E+01	1.36E+00	1.95E-02	8.36E-02	1.31E-01	1.12E-02
150	6.30E+00	1.32E-02	5.94E+00	5.90E-01	8.46E-03	3.62E-02	5.67E-02	4.83E-03
250	1.18E+00	2.48E-03	1.11E+00	1.11E-01	1.59E-03	6.78E-03	1.06E-02	9.05E-04
500	1.79E-02	3.77E-05	1.69E-02	1.68E-03	2.41E-05	1.03E-04	1.62E-04	1.38E-05
750	2.72E-04	5.73E-07	2.57E-04	2.56E-05	3.66E-07	1.57E-06	2.45E-06	2.09E-07
1000	3.94E-06	8.28E-09	3.72E-06	3.69E-07	5.29E-09	2.26E-08	3.54E-08	3.02E-09
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Overburden

Uncapped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.15E-35	7.46E-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	9.28E-29	0.00E+00	7.13E-05	7.82E-08	1.72E-11	0.00E+00	3.42E-24	0.00E+00
4	2.87E-12	0.00E+00	9.19E-01	2.75E-04	1.79E-06	0.00E+00	7.11E-11	0.00E+00
6	9.65E-07	0.00E+00	4.89E+00	3.63E-04	7.94E-06	0.00E+00	6.55E-08	0.00E+00
8	2.30E-04	0.00E+00	7.95E+00	3.07E-04	9.11E-06	0.00E+00	7.85E-07	0.00E+00
10	4.95E-03	0.00E+00	9.27E+00	2.52E-04	8.05E-06	0.00E+00	3.05E-06	0.00E+00
20	1.01E+00	0.00E+00	5.47E+00	9.26E-05	3.06E-06	0.00E+00	7.23E-06	0.00E+00
30	3.32E+00	1.83E-40	2.09E+00	3.41E-05	1.13E-06	0.00E+00	3.70E-06	0.00E+00
40	3.87E+00	6.53E-35	7.71E-01	1.25E-05	4.15E-07	0.00E+00	1.44E-06	0.00E+00
50	3.31E+00	1.41E-32	2.84E-01	4.61E-06	1.53E-07	0.00E+00	5.31E-07	0.00E+00
60	2.41E+00	1.34E-30	1.04E-01	1.70E-06	5.61E-08	0.00E+00	1.97E-07	1.84E-40
70	1.70E+00	2.42E-27	3.84E-02	6.24E-07	2.06E-08	0.00E+00	7.27E-08	2.23E-36
80	1.09E+00	1.48E-25	1.41E-02	2.30E-07	7.60E-09	2.69E-40	2.68E-08	5.33E-35
100	3.42E-01	1.93E-21	1.91E-03	3.11E-08	1.03E-09	3.00E-35	3.62E-09	3.87E-32
150	1.32E-02	1.43E-15	1.29E-05	2.08E-10	6.89E-12	1.81E-31	2.44E-11	4.00E-27
250	2.30E-05	5.73E-10	0.00E+00	0.00E+00	0.00E+00	1.38E-22	5.09E-23	5.30E-19
500	3.73E-09	4.12E-06	0.00E+00	0.00E+00	0.00E+00	5.48E-13	0.00E+00	1.15E-10
750	2.37E-12	4.97E-05	0.00E+00	0.00E+00	0.00E+00	3.34E-09	0.00E+00	4.12E-08
1000	3.19E-14	1.08E-04	0.00E+00	0.00E+00	0.00E+00	2.09E-07	0.00E+00	7.11E-07
2000	0.00E+00	9.73E-05	0.00E+00	0.00E+00	0.00E+00	3.36E-05	0.00E+00	1.26E-05

Capped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.05E-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	6.42E-30	0.00E+00	1.88E-05	2.23E-08	3.67E-12	0.00E+00	3.38E-24	0.00E+00
4	3.46E-13	0.00E+00	2.84E-01	8.59E-05	3.91E-07	0.00E+00	1.71E-11	0.00E+00
6	1.70E-07	0.00E+00	1.59E+00	1.31E-04	1.90E-06	0.00E+00	2.72E-08	0.00E+00
8	4.69E-05	0.00E+00	2.81E+00	1.29E-04	2.77E-06	0.00E+00	4.42E-07	0.00E+00
10	1.11E-03	0.00E+00	3.55E+00	1.25E-04	2.88E-06	0.00E+00	1.33E-06	0.00E+00
20	3.22E-01	0.00E+00	4.31E+00	1.06E-04	2.53E-06	0.00E+00	4.60E-06	0.00E+00
30	1.45E+00	0.00E+00	3.74E+00	8.96E-05	2.14E-06	0.00E+00	4.07E-06	0.00E+00
40	2.56E+00	3.78E-36	3.17E+00	7.58E-05	1.81E-06	0.00E+00	3.44E-06	0.00E+00
50	3.15E+00	1.92E-34	2.68E+00	6.41E-05	1.53E-06	0.00E+00	2.91E-06	0.00E+00
60	3.34E+00	4.10E-31	2.26E+00	5.42E-05	1.29E-06	0.00E+00	2.46E-06	0.00E+00
70	3.25E+00	2.47E-27	1.92E+00	4.58E-05	1.09E-06	0.00E+00	2.08E-06	5.58E-38
80	3.03E+00	2.00E-24	1.62E+00	3.88E-05	9.26E-07	0.00E+00	1.76E-06	8.26E-36
100	2.43E+00	1.11E-21	1.16E+00	2.77E-05	6.62E-07	4.75E-36	1.26E-06	6.07E-33
150	1.12E+00	1.64E-16	5.02E-01	1.20E-05	2.87E-07	1.20E-31	5.45E-07	2.58E-25
250	2.14E-01	1.60E-10	9.40E-02	2.25E-06	5.37E-08	2.02E-23	1.02E-07	3.57E-19
500	3.26E-03	3.31E-06	1.43E-03	3.42E-08	8.17E-10	1.03E-13	1.55E-09	1.30E-10
750	4.96E-05	5.37E-05	2.17E-05	5.20E-10	1.24E-11	1.21E-09	2.36E-11	5.63E-08
1000	7.47E-07	1.46E-04	3.13E-07	7.49E-12	1.79E-13	1.14E-07	3.45E-13	8.07E-07
2000	0.00E+00	1.73E-04	0.00E+00	0.00E+00	0.00E+00	3.70E-05	0.00E+00	2.02E-05

Uncapped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	7.33E-24	5.85E-26	1.63E-31	0.00E+00	0.00E+00	0.00E+00
2	1.10E-15	0.00E+00	5.09E-02	1.61E-04	4.68E-07	0.00E+00	2.75E-10	0.00E+00
4	1.71E-04	0.00E+00	6.63E+00	7.30E-03	2.05E-04	0.00E+00	1.06E-04	0.00E+00
6	4.59E-02	0.00E+00	1.49E+01	6.72E-03	3.67E-04	0.00E+00	1.12E-03	0.00E+00
8	4.89E-01	0.00E+00	1.93E+01	5.52E-03	3.31E-04	0.00E+00	2.43E-03	1.27E-38
10	1.52E+00	9.91E-39	2.03E+01	4.52E-03	2.88E-04	0.00E+00	3.03E-03	5.43E-34
20	8.43E+00	1.79E-27	1.38E+01	1.66E-03	1.07E-04	1.00E-34	1.78E-03	1.34E-21
30	9.00E+00	2.30E-23	6.54E+00	6.11E-04	3.93E-05	2.74E-29	6.79E-04	9.31E-18
40	8.36E+00	5.75E-20	2.58E+00	2.25E-04	1.45E-05	9.26E-24	2.52E-04	1.36E-13
50	7.36E+00	1.20E-17	9.58E-01	8.27E-05	5.32E-06	4.93E-23	9.27E-05	3.88E-11
60	6.05E+00	8.17E-15	3.56E-01	3.04E-05	1.96E-06	3.36E-21	3.41E-05	1.58E-09
70	4.94E+00	7.59E-13	1.32E-01	1.12E-05	7.20E-07	6.20E-19	1.25E-05	2.14E-08
80	4.14E+00	2.08E-11	4.86E-02	4.12E-06	2.65E-07	2.14E-16	4.62E-06	1.45E-07
100	2.68E+00	2.46E-09	6.59E-03	5.57E-07	3.58E-08	2.61E-13	6.25E-07	1.95E-06
150	7.41E-01	8.61E-07	4.45E-05	3.73E-09	2.40E-10	2.92E-09	4.21E-09	4.58E-05
250	3.14E-02	6.33E-05	1.81E-11	0.00E+00	0.00E+00	3.16E-06	6.51E-14	1.73E-04
500	1.54E-05	5.00E-04	0.00E+00	0.00E+00	0.00E+00	3.27E-04	0.00E+00	1.93E-04
750	8.18E-08	5.50E-04	0.00E+00	0.00E+00	0.00E+00	6.33E-04	0.00E+00	1.75E-04
1000	2.39E-09	4.88E-04	0.00E+00	0.00E+00	0.00E+00	6.83E-04	0.00E+00	1.60E-04
2000	0.00E+00	3.21E-04	0.00E+00	0.00E+00	0.00E+00	5.81E-04	0.00E+00	9.31E-05

Capped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	2.32E-24	5.23E-27	1.62E-32	0.00E+00	0.00E+00	0.00E+00
2	3.87E-16	0.00E+00	9.06E-03	3.60E-05	9.92E-08	0.00E+00	2.09E-11	0.00E+00
4	6.46E-05	0.00E+00	1.95E+00	1.90E-03	5.59E-05	0.00E+00	2.53E-05	0.00E+00
6	1.51E-02	0.00E+00	4.74E+00	2.01E-03	1.11E-04	0.00E+00	3.01E-04	0.00E+00
8	1.54E-01	0.00E+00	6.67E+00	1.94E-03	1.23E-04	0.00E+00	6.66E-04	0.00E+00
10	4.65E-01	6.25E-37	8.19E+00	1.88E-03	1.23E-04	0.00E+00	1.07E-03	1.47E-35
20	3.37E+00	4.09E-27	1.05E+01	1.59E-03	1.04E-04	1.92E-35	1.29E-03	1.14E-24
30	5.33E+00	2.63E-22	9.55E+00	1.34E-03	8.80E-05	9.22E-27	1.10E-03	7.84E-19
40	6.31E+00	5.46E-20	8.21E+00	1.14E-03	7.44E-05	3.24E-22	9.33E-04	1.50E-14
50	6.58E+00	2.86E-16	7.01E+00	9.61E-04	6.30E-05	4.19E-21	7.89E-04	5.51E-12
60	6.68E+00	8.42E-14	5.93E+00	8.13E-04	5.33E-05	1.72E-19	6.67E-04	2.71E-10
70	6.78E+00	4.48E-12	5.02E+00	6.88E-04	4.50E-05	2.33E-16	5.64E-04	3.56E-09
80	6.72E+00	9.22E-11	4.24E+00	5.82E-04	3.81E-05	2.07E-14	4.77E-04	2.69E-08
100	6.41E+00	6.39E-09	3.04E+00	4.16E-04	2.73E-05	1.08E-11	3.42E-04	4.97E-07
150	4.00E+00	1.54E-06	1.31E+00	1.80E-04	1.18E-05	3.65E-08	1.48E-04	2.39E-05
250	9.63E-01	1.11E-04	2.46E-01	3.38E-05	2.21E-06	1.92E-05	2.77E-05	1.78E-04
500	1.60E-02	9.03E-04	3.75E-03	5.13E-07	3.36E-08	8.61E-04	4.21E-07	3.44E-04
750	2.43E-04	9.61E-04	5.69E-05	7.80E-09	5.11E-10	1.35E-03	6.40E-09	2.71E-04
1000	3.71E-06	8.42E-04	8.24E-07	1.12E-10	7.36E-12	1.49E-03	9.28E-11	2.38E-04
2000	1.73E-12	5.79E-04	0.00E+00	0.00E+00	0.00E+00	1.00E-03	0.00E+00	1.71E-04

Overburden at the River Morell

Uncapped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	3.12E-32	0.00E+00	3.14E-07	1.96E-10	7.25E-15	0.00E+00	3.82E-31	0.00E+00
4	7.49E-17	0.00E+00	1.67E-01	2.67E-05	1.01E-07	0.00E+00	3.44E-14	0.00E+00
6	9.11E-10	0.00E+00	2.11E+00	6.41E-05	1.17E-06	0.00E+00	6.07E-10	0.00E+00
8	1.65E-06	0.00E+00	4.99E+00	5.66E-05	1.64E-06	0.00E+00	2.32E-08	0.00E+00
10	1.04E-04	0.00E+00	7.01E+00	4.65E-05	1.57E-06	0.00E+00	1.42E-07	0.00E+00
20	1.96E-01	0.00E+00	6.43E+00	1.71E-05	6.67E-07	0.00E+00	1.04E-06	0.00E+00
30	1.41E+00	0.00E+00	2.67E+00	6.29E-06	2.45E-07	0.00E+00	6.38E-07	0.00E+00
40	2.74E+00	6.33E-39	1.01E+00	2.31E-06	9.03E-08	0.00E+00	2.54E-07	0.00E+00
50	3.02E+00	3.99E-36	3.78E-01	8.52E-07	3.32E-08	0.00E+00	9.51E-08	0.00E+00
60	2.74E+00	5.11E-34	1.39E-01	3.13E-07	1.22E-08	0.00E+00	3.50E-08	0.00E+00
70	2.19E+00	2.07E-32	5.12E-02	1.15E-07	4.49E-09	0.00E+00	1.29E-08	0.00E+00
80	1.69E+00	2.08E-29	1.88E-02	4.24E-08	1.65E-09	0.00E+00	4.73E-09	1.89E-40
100	9.18E-01	1.20E-26	2.55E-03	5.74E-09	2.24E-10	0.00E+00	6.41E-10	4.82E-37
150	8.98E-02	1.93E-20	1.72E-05	3.85E-11	1.50E-12	4.53E-35	4.32E-12	1.23E-31
250	6.14E-04	6.39E-13	8.74E-13	0.00E+00	0.00E+00	6.67E-27	3.00E-20	3.17E-23
500	1.86E-08	1.68E-07	0.00E+00	0.00E+00	0.00E+00	3.73E-17	0.00E+00	1.35E-13
750	9.19E-12	6.94E-06	0.00E+00	0.00E+00	0.00E+00	5.85E-12	0.00E+00	5.48E-10
1000	1.06E-12	3.49E-05	0.00E+00	0.00E+00	0.00E+00	2.03E-09	0.00E+00	2.66E-08
2000	0.00E+00	9.14E-05	0.00E+00	0.00E+00	0.00E+00	5.86E-06	0.00E+00	4.42E-06

Capped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	1.10E-31	0.00E+00	8.21E-08	4.66E-11	1.43E-15	0.00E+00	8.84E-30	0.00E+00
4	1.90E-17	0.00E+00	4.53E-02	8.24E-06	1.98E-08	0.00E+00	9.77E-15	0.00E+00
6	1.23E-10	0.00E+00	6.44E-01	2.26E-05	2.29E-07	0.00E+00	2.39E-10	0.00E+00
8	3.01E-07	0.00E+00	1.68E+00	2.32E-05	4.09E-07	0.00E+00	1.39E-08	0.00E+00
10	2.23E-05	0.00E+00	2.56E+00	2.25E-05	4.95E-07	0.00E+00	8.00E-08	0.00E+00
20	5.54E-02	0.00E+00	4.26E+00	1.90E-05	4.59E-07	0.00E+00	5.60E-07	0.00E+00
30	5.37E-01	0.00E+00	3.84E+00	1.61E-05	3.88E-07	0.00E+00	5.79E-07	0.00E+00
40	1.37E+00	1.72E-39	3.28E+00	1.36E-05	3.29E-07	0.00E+00	5.14E-07	0.00E+00
50	2.19E+00	5.55E-36	2.78E+00	1.15E-05	2.78E-07	0.00E+00	4.34E-07	0.00E+00
60	2.63E+00	7.52E-34	2.35E+00	9.73E-06	2.35E-07	0.00E+00	3.68E-07	0.00E+00
70	2.87E+00	4.89E-32	1.99E+00	8.23E-06	1.99E-07	0.00E+00	3.11E-07	0.00E+00
80	2.92E+00	2.49E-30	1.68E+00	6.96E-06	1.68E-07	0.00E+00	2.63E-07	1.16E-39
100	2.57E+00	1.44E-26	1.20E+00	4.98E-06	1.20E-07	0.00E+00	1.88E-07	1.70E-35
150	1.41E+00	1.55E-20	5.20E-01	2.16E-06	5.21E-08	2.83E-34	8.14E-08	2.67E-31
250	2.83E-01	1.14E-13	9.75E-02	4.04E-07	9.76E-09	3.65E-27	1.53E-08	1.02E-22
500	4.36E-03	1.01E-07	1.48E-03	6.14E-09	1.48E-10	4.88E-18	2.32E-10	1.44E-13
750	6.63E-05	7.18E-06	2.25E-05	9.33E-11	2.25E-12	1.58E-12	3.52E-12	7.46E-10
1000	1.00E-06	4.01E-05	3.28E-07	1.34E-12	3.25E-14	8.14E-10	5.10E-14	3.40E-08
2000	0.00E+00	1.57E-04	0.00E+00	0.00E+00	0.00E+00	5.31E-06	0.00E+00	6.28E-06

Uncapped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	3.57E-28	2.42E-30	1.38E-35	0.00E+00	0.00E+00	0.00E+00
2	1.19E-18	0.00E+00	2.57E-03	5.07E-06	6.91E-09	0.00E+00	1.06E-13	0.00E+00
4	1.35E-06	0.00E+00	2.96E+00	1.61E-03	3.94E-05	0.00E+00	6.07E-06	0.00E+00
6	2.08E-03	0.00E+00	1.02E+01	1.86E-03	1.19E-04	0.00E+00	1.71E-04	0.00E+00
8	5.68E-02	0.00E+00	1.43E+01	1.53E-03	1.31E-04	0.00E+00	6.49E-04	0.00E+00
10	3.45E-01	0.00E+00	1.74E+01	1.25E-03	1.10E-04	0.00E+00	9.88E-04	3.96E-38
20	5.05E+00	5.93E-32	1.48E+01	4.60E-04	4.10E-05	1.17E-40	7.73E-04	3.08E-24
30	7.37E+00	1.10E-26	8.64E+00	1.69E-04	1.51E-05	2.86E-32	3.01E-04	1.19E-21
40	7.10E+00	1.82E-23	4.08E+00	6.22E-05	5.55E-06	3.01E-30	1.11E-04	6.93E-18
50	6.75E+00	2.50E-21	1.66E+00	2.29E-05	2.04E-06	8.33E-27	4.09E-05	1.51E-14
60	6.00E+00	1.07E-19	6.39E-01	8.42E-06	7.51E-07	8.57E-25	1.51E-05	2.39E-12
70	5.23E+00	5.49E-17	2.40E-01	3.10E-06	2.76E-07	2.96E-21	5.54E-06	8.50E-11
80	4.46E+00	5.52E-15	8.91E-02	1.14E-06	1.02E-07	2.10E-21	2.04E-06	1.20E-09
100	3.34E+00	3.15E-12	1.22E-02	1.54E-07	1.38E-08	1.19E-17	2.76E-07	4.54E-08
150	1.47E+00	1.33E-08	8.36E-05	1.03E-09	9.25E-11	3.94E-12	1.86E-09	4.57E-06
250	1.64E-01	6.21E-06	6.60E-09	0.00E+00	0.00E+00	8.71E-08	5.64E-14	9.66E-05
500	4.49E-04	2.12E-04	0.00E+00	0.00E+00	0.00E+00	6.26E-05	1.88E-22	1.37E-04
750	1.59E-06	4.01E-04	0.00E+00	0.00E+00	0.00E+00	3.28E-04	0.00E+00	1.31E-04
1000	1.83E-08	4.09E-04	0.00E+00	0.00E+00	0.00E+00	4.70E-04	0.00E+00	1.32E-04
2000	5.98E-13	2.98E-04	0.00E+00	0.00E+00	0.00E+00	5.19E-04	0.00E+00	9.24E-05

Capped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.15E-28	3.80E-31	5.78E-36	0.00E+00	0.00E+00	0.00E+00
2	3.03E-19	0.00E+00	3.98E-04	9.71E-07	1.25E-09	0.00E+00	4.62E-15	0.00E+00
4	4.14E-07	0.00E+00	7.32E-01	4.29E-04	1.04E-05	0.00E+00	1.11E-06	0.00E+00
6	7.93E-04	0.00E+00	2.97E+00	5.56E-04	3.23E-05	0.00E+00	4.73E-05	0.00E+00
8	1.90E-02	0.00E+00	4.85E+00	5.39E-04	4.10E-05	0.00E+00	1.65E-04	0.00E+00
10	1.09E-01	0.00E+00	6.28E+00	5.21E-04	4.21E-05	0.00E+00	2.94E-04	0.00E+00
20	1.86E+00	1.43E-31	9.82E+00	4.41E-04	3.62E-05	4.36E-39	4.96E-04	1.68E-30
30	3.76E+00	1.69E-25	9.69E+00	3.73E-04	3.07E-05	2.07E-31	4.32E-04	2.58E-22
40	5.00E+00	2.39E-22	8.65E+00	3.16E-04	2.59E-05	6.37E-27	3.65E-04	5.82E-19
50	5.66E+00	2.25E-20	7.43E+00	2.67E-04	2.19E-05	2.79E-26	3.09E-04	1.63E-15
60	5.87E+00	4.30E-18	6.30E+00	2.26E-04	1.85E-05	2.63E-23	2.61E-04	3.04E-13
70	5.94E+00	1.03E-15	5.33E+00	1.91E-04	1.57E-05	6.56E-20	2.21E-04	1.33E-11
80	5.88E+00	6.12E-14	4.51E+00	1.61E-04	1.33E-05	1.66E-19	1.87E-04	2.21E-10
100	5.82E+00	1.59E-11	3.23E+00	1.16E-04	9.49E-06	1.71E-15	1.34E-04	8.58E-09
150	4.44E+00	3.20E-08	1.40E+00	5.00E-05	4.11E-06	1.27E-10	5.79E-05	1.55E-06
250	1.59E+00	1.11E-05	2.62E-01	9.37E-06	7.70E-07	7.55E-07	1.09E-05	5.01E-05
500	3.55E-02	4.31E-04	3.99E-03	1.43E-07	1.17E-08	2.31E-04	1.65E-07	2.45E-04
750	5.94E-04	7.11E-04	6.06E-05	2.16E-09	1.78E-10	8.61E-04	2.51E-09	2.48E-04
1000	9.18E-06	7.13E-04	8.87E-07	3.12E-11	2.56E-12	1.01E-03	3.63E-11	1.98E-04
2000	2.59E-12	5.07E-04	0.00E+00	0.00E+00	0.00E+00	8.99E-04	0.00E+00	1.56E-04

Limestone Aquifer

Uncapped 50 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	2.35E-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	6.66E-05	9.56E-14	1.16E-26	0.00E+00	0.00E+00	0.00E+00
4	2.45E-39	0.00E+00	2.34E+00	8.27E-06	5.82E-13	0.00E+00	2.30E-35	0.00E+00
6	5.95E-30	0.00E+00	7.09E+00	3.51E-05	6.36E-10	0.00E+00	2.43E-28	0.00E+00
8	1.69E-26	0.00E+00	8.57E+00	3.35E-05	4.47E-09	0.00E+00	1.38E-24	0.00E+00
10	1.49E-22	0.00E+00	8.48E+00	2.78E-05	9.37E-09	0.00E+00	6.20E-21	0.00E+00
20	7.59E-12	0.00E+00	4.20E+00	1.02E-05	6.75E-09	0.00E+00	3.64E-14	0.00E+00
30	6.80E-07	0.00E+00	1.64E+00	3.76E-06	2.53E-09	0.00E+00	5.61E-13	0.00E+00
40	1.46E-04	0.00E+00	6.08E-01	1.38E-06	9.33E-10	0.00E+00	1.04E-12	0.00E+00
50	2.88E-03	0.00E+00	2.24E-01	5.09E-07	3.43E-10	0.00E+00	7.22E-13	0.00E+00
60	1.90E-02	0.00E+00	8.26E-02	1.87E-07	1.26E-10	0.00E+00	3.70E-13	0.00E+00
70	6.74E-02	0.00E+00	3.04E-02	6.89E-08	4.64E-11	0.00E+00	1.42E-13	0.00E+00
80	1.59E-01	0.00E+00	1.12E-02	2.53E-08	1.71E-11	0.00E+00	5.25E-14	0.00E+00
100	4.03E-01	0.00E+00	1.51E-03	3.43E-09	2.31E-12	0.00E+00	7.11E-15	0.00E+00
150	5.58E-01	0.00E+00	1.02E-05	2.30E-11	1.56E-14	0.00E+00	4.79E-17	0.00E+00
250	2.99E-01	5.82E-35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.28E-22	0.00E+00
500	2.05E-02	1.58E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.66E-35
750	6.85E-04	5.59E-21	0.00E+00	0.00E+00	0.00E+00	5.18E-34	0.00E+00	4.84E-31
1000	2.13E-05	2.28E-16	0.00E+00	0.00E+00	0.00E+00	6.48E-31	0.00E+00	1.70E-26
2000	1.28E-09	4.84E-09	0.00E+00	0.00E+00	0.00E+00	8.68E-22	0.00E+00	5.77E-16

Capped 50 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	5.61E-39	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	2.11E-05	8.49E-15	4.65E-28	0.00E+00	0.00E+00	0.00E+00
4	0.00E+00	0.00E+00	6.83E-01	1.76E-06	7.20E-14	0.00E+00	1.28E-38	0.00E+00
6	1.41E-31	0.00E+00	2.42E+00	9.75E-06	8.75E-11	0.00E+00	1.57E-31	0.00E+00
8	9.33E-30	0.00E+00	3.15E+00	1.08E-05	8.27E-10	0.00E+00	1.27E-25	0.00E+00
10	1.77E-25	0.00E+00	3.46E+00	1.05E-05	1.80E-09	0.00E+00	4.43E-22	0.00E+00
20	6.43E-13	0.00E+00	3.45E+00	8.91E-06	3.31E-09	0.00E+00	4.08E-15	0.00E+00
30	9.80E-08	0.00E+00	2.99E+00	7.54E-06	2.80E-09	0.00E+00	1.16E-13	0.00E+00
40	2.96E-05	0.00E+00	2.57E+00	6.37E-06	2.37E-09	0.00E+00	4.63E-13	0.00E+00
50	7.47E-04	0.00E+00	2.18E+00	5.39E-06	2.00E-09	0.00E+00	5.33E-13	0.00E+00
60	5.87E-03	0.00E+00	1.84E+00	4.56E-06	1.69E-09	0.00E+00	4.67E-13	0.00E+00
70	2.41E-02	0.00E+00	1.56E+00	3.86E-06	1.43E-09	0.00E+00	3.96E-13	0.00E+00
80	6.45E-02	0.00E+00	1.32E+00	3.26E-06	1.21E-09	0.00E+00	3.35E-13	0.00E+00
100	2.27E-01	0.00E+00	9.46E-01	2.33E-06	8.67E-10	0.00E+00	2.40E-13	0.00E+00
150	7.85E-01	0.00E+00	4.10E-01	1.01E-06	3.75E-10	0.00E+00	1.04E-13	0.00E+00
250	7.46E-01	1.46E-37	7.68E-02	1.89E-07	7.04E-11	0.00E+00	1.94E-14	0.00E+00
500	1.11E-01	3.72E-28	1.17E-03	2.88E-09	1.07E-12	0.00E+00	2.96E-16	1.43E-36
750	6.15E-03	3.10E-21	1.77E-05	4.37E-11	1.62E-14	9.27E-35	4.50E-18	3.26E-33
1000	2.49E-04	5.32E-17	2.56E-07	6.30E-13	2.35E-16	1.58E-32	6.78E-20	3.15E-28
2000	3.77E-09	3.64E-09	0.00E+00	0.00E+00	0.00E+00	4.00E-21	0.00E+00	8.29E-17

Uncapped 95 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.90E-21	1.27E-30	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	1.78E-36	0.00E+00	1.98E+00	2.34E-05	1.00E-11	0.00E+00	3.65E-26	0.00E+00
4	8.44E-22	0.00E+00	1.80E+01	6.14E-03	1.02E-05	0.00E+00	6.26E-15	0.00E+00
6	7.24E-16	0.00E+00	2.21E+01	5.61E-03	4.39E-05	0.00E+00	1.38E-09	0.00E+00
8	3.63E-11	0.00E+00	2.16E+01	4.59E-03	6.14E-05	0.00E+00	1.93E-07	0.00E+00
10	4.56E-08	0.00E+00	2.02E+01	3.76E-03	6.47E-05	0.00E+00	2.15E-06	0.00E+00
20	1.36E-02	0.00E+00	1.05E+01	1.38E-03	2.53E-05	0.00E+00	3.53E-05	0.00E+00
30	3.80E-01	0.00E+00	5.08E+00	5.09E-04	9.30E-06	0.00E+00	1.94E-05	0.00E+00
40	1.49E+00	0.00E+00	2.43E+00	1.87E-04	3.42E-06	0.00E+00	7.29E-06	1.06E-39
50	2.61E+00	0.00E+00	1.11E+00	6.89E-05	1.26E-06	0.00E+00	2.71E-06	4.30E-34
60	3.07E+00	2.78E-39	4.65E-01	2.53E-05	4.63E-07	0.00E+00	9.97E-07	4.82E-33
70	3.01E+00	6.27E-36	1.79E-01	9.32E-06	1.70E-07	0.00E+00	3.67E-07	1.57E-30
80	3.06E+00	1.08E-32	6.63E-02	3.43E-06	6.26E-08	0.00E+00	1.35E-07	9.92E-29
100	2.79E+00	1.01E-30	9.21E-03	4.64E-07	8.48E-09	1.20E-39	1.83E-08	1.02E-25
150	2.04E+00	2.85E-25	6.65E-05	3.10E-09	5.71E-11	4.08E-33	1.23E-10	7.88E-21
250	1.12E+00	1.69E-19	7.46E-09	0.00E+00	1.35E-21	1.12E-25	1.30E-14	1.36E-13
500	4.54E-01	4.12E-11	0.00E+00	0.00E+00	0.00E+00	8.12E-17	2.04E-18	1.50E-07
750	1.93E-01	6.42E-08	0.00E+00	0.00E+00	0.00E+00	2.24E-11	1.05E-24	6.25E-06
1000	9.58E-02	1.63E-06	0.00E+00	0.00E+00	0.00E+00	7.64E-09	2.46E-33	1.55E-05
2000	4.12E-03	7.25E-05	0.00E+00	0.00E+00	0.00E+00	1.50E-05	0.00E+00	3.57E-05

Capped 95 th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	4.66E-22	9.37E-32	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	7.39E-37	0.00E+00	5.51E-01	9.09E-06	7.35E-12	0.00E+00	3.23E-27	0.00E+00
4	1.76E-22	0.00E+00	5.86E+00	2.06E-03	4.08E-06	0.00E+00	6.63E-15	0.00E+00
6	8.46E-17	0.00E+00	7.93E+00	2.31E-03	1.78E-05	0.00E+00	9.08E-10	0.00E+00
8	2.69E-12	0.00E+00	8.66E+00	2.24E-03	2.46E-05	0.00E+00	8.89E-08	0.00E+00
10	4.95E-09	0.00E+00	8.88E+00	2.16E-03	2.47E-05	0.00E+00	1.33E-06	0.00E+00
20	2.83E-03	0.00E+00	8.25E+00	1.83E-03	2.14E-05	0.00E+00	1.54E-05	0.00E+00
30	1.06E-01	0.00E+00	7.26E+00	1.55E-03	1.81E-05	0.00E+00	1.74E-05	0.00E+00
40	5.48E-01	0.00E+00	6.50E+00	1.31E-03	1.53E-05	0.00E+00	1.48E-05	0.00E+00
50	1.07E+00	0.00E+00	5.60E+00	1.11E-03	1.29E-05	0.00E+00	1.25E-05	0.00E+00
60	1.79E+00	4.65E-37	4.80E+00	9.37E-04	1.10E-05	0.00E+00	1.06E-05	1.02E-37
70	2.36E+00	3.15E-33	4.07E+00	7.92E-04	9.26E-06	0.00E+00	8.93E-06	1.47E-34
80	2.70E+00	3.94E-32	3.45E+00	6.70E-04	7.83E-06	0.00E+00	7.55E-06	4.60E-32
100	3.07E+00	5.52E-30	2.48E+00	4.79E-04	5.60E-06	2.52E-37	5.40E-06	1.04E-30
150	3.00E+00	4.91E-24	1.08E+00	2.08E-04	2.43E-06	1.55E-30	2.34E-06	1.25E-24
250	2.20E+00	2.76E-19	2.03E-01	3.89E-05	4.55E-07	3.41E-23	4.38E-07	1.54E-18
500	9.74E-01	3.38E-10	3.08E-03	5.91E-07	6.91E-09	5.98E-16	6.67E-09	1.64E-09
750	4.30E-01	3.29E-07	4.68E-05	8.98E-09	1.05E-10	8.50E-11	1.01E-10	6.71E-07
1000	2.10E-01	6.40E-06	6.77E-07	1.30E-10	1.51E-12	2.51E-08	1.47E-12	3.20E-06
2000	9.92E-03	1.34E-04	0.00E+00	0.00E+00	0.00E+00	3.44E-05	0.00E+00	3.38E-05

Appendix D. Zone 3 input parameters

Infiltration Used in LandSim Model

Parameter	Units	Distribution	Justification
Active tipping phase			
Infiltration to open waste or via temporary cover	mm/yr	Uniform (530 to 720)	70 to 95 % of average Rainfall
Post-tipping phase			
Current model Infiltration following capping of landfill	mm/yr	Uniform (250 to 450)	Jacobs' experience of evapotranspiration calculations and as used in previous assessment
Capped model Infiltration following capping of landfill	mm/yr	Uniform (25 to 50)	To reflect reduced infiltration following capping. Professional experience of similar simulations

Landfill Geometry

LandSim Model Base Area	Area (Ha)	Final Waste Thickness (m)
Current Model	1.35	Uniform (1 - 15)
Capped Model	1.875	Uniform (4 - 19)

Leachate Quality – Uncapped Scenario

Determinand	Minimum (mg/l)	Likely (mg/l)	Maximum (mg/l)	Source
Ammoniacal nitrogen	88	350	833	Zone 3 leachate quality monitoring (2010 to 2016)
Arsenic	0.0005	0.073	0.224	Zone 3 leachate quality monitoring as used in Zone 1 DQRA (Reference 7)
Benzene (o)	0.0007	0.0038	0.0059	Zone 3 leachate quality monitoring as used in Zone 1 DQRA (Reference 7)
Cadmium	0.0000006	0.00014	0.0003	Zone 3 leachate quality monitoring as used in Zone 1 DQRA (Reference 7)
Chloride	171	434	1142	Zone 3 leachate quality monitoring (2010 to 2016)
Formaldehyde (o)	0.0001	0.1	10	Text book values as used in Zone 1 DQRA (Reference 7)
Mecoprop (o)	0.001	0.011	0.14	Text book values as used in Zone 1 DQRA (Reference 7)
Mercury	0.00005	0.000092	0.0001	Zone 3 leachate quality monitoring as used in Zone 1 DQRA (Reference 7)
Nickel	0.0003	0.203	0.605	Zone 3 leachate quality monitoring as used in Zone 1 DQRA (Reference 7)
Phenol (o)	0.001	0.03	1	Text book values as used in

Determinand	Minimum (mg/l)	Likely (mg/l)	Maximum (mg/l)	Source
				Zone 1 DQRA (Reference 7)
Zinc	0.013	0.302	1.6	Zone 3 leachate quality monitoring as used in Zone 1 DQRA (Reference 7)

(o) – indicates organic compound

Leachate Quality – Capped and Fully Landfilled Scenario (based on Zone 1 RAM results)

Determinand	Minimum (mg/l)	Likely (mg/l)	Maximum (mg/l)
Ammoniacal nitrogen	88	140	500
Arsenic	0.0005	0.073	0.224
Benzene (o)	0.0007	0.0038	0.0059
Cadmium	0.0000006	0.00014	0.0003
Chloride	70	200	800
Formaldehyde (o)	0.0001	0.1	10
Mecoprop (o)	0.001	0.011	0.3
Mercury	0.00005	0.0000917	0.0001
Nickel	0.0003	0.303	0.605
Phenol (o)	0.001	0.03	1.2
Zinc	0.013	0.302	1.6

Inputs for Declining Source Term

Parameter	Units	Distribution		Justification
		M	C	
Field capacity of waste	fraction	Uniform (0.2, 0.3)		Values as used in Zone 1 DQRA (Reference 7)
Waste porosity	fraction	Uniform (0.25, 0.4)		
Waste density	Kg/l	Uniform (0.8, 1)		
Kappa values for declining source*				
Ammoniacal Nitrogen	Kg/l	0	0.59	Values as used in Zone 1 DQRA (Reference 7)
Arsenic	Kg/l	0.0415	0.0862	
Benzene (o)	Kg/l	0.298	0.2919	
Cadmium	Kg/l	0.0823	0.1589	
Chloride	Kg/l	0.0298	0.2919	
Formaldehyde (o)	Kg/l	0.0298	0.2919	
Mecoprop (o)	Kg/l	0.0298	0.2919	
Mercury	Kg/l	0.0767	0.1643	
Nickel	Kg/l	0.0987	0.1479	
Phenol (o)	Kg/l	0	0.36	
Zinc	Kg/l	0.0403	0.0561	
* m and c are the slope of the line and the x-axis intercept respectively when the experimental data are plotted with initial leachate concentration on the x axis and kappa on the y axis.				

Inputs Used for LandSim Unsaturated Zone

Model	Thickness (m)	Hydraulic Conductivity (m/s)	Moisture Content (fraction)	Density (kg/l)
Unsaturated Pathway	Single (0.3)	Uniform (1.16 x 10-6, 1.16 x 10-7)	Uniform (0.34, 0.6)	Uniform (1, 2.4)
Vertical Pathway	Uniform (4, 7)	Uniform (1.16 x 10-6, 1.16 x 10-7)	Uniform (0.34, 0.6)	Uniform (1, 2.4)

Aquifer Properties

Model	Parameter	Distribution	Justification
Aquifer Pathway (Bedrock)	Regional gradient (-)	Uniform (0.002, 0.003)	As measured on site
	Mixing zone thickness (m)	Uniform (2.5, 5)	Transition zone in the bedrock
	Pathway porosity (fraction)	Uniform (0.01, 0.1)	Assumes fracture flow
	Hydraulic conductivity (m/s)	0.0000625	As measured in site permeability test in EMW12D and assuming transition zone has relatively high permeability
Aquifer Pathway (Overburden)	Regional gradient (-)	Single (0.04)	As measured on site
	Mixing zone thickness (m)	Uniform (2.5, 5)	Assumes mixing is relatively narrow due to layering in overburden deposits
	Pathway Porosity (fraction)	Uniform (0.34, 0.6)	Sand and gravel aquifer from ConSim help file
	Hydraulic Conductivity (m/s)	Uniform (1.16 x 10-7, 1.16 x 10-6)	Typical value for silty sand and gravel, within the middle of the range of on-site measurements

Retardation and Decay Parameters

Determinand	Assumed Background Concentration (mg/l)	Unsaturated Zone / Vertical / Aquifer Pathway half-life (years)	Source	Kd / KoC (l/kg)	Source	Fraction of Organic Carbon (foc) (fraction) - Bedrock Pathway	Fraction of Organic Carbon (foc) (fraction) - Unsaturated / Vertical Pathway	Source
Ammoniacal nitrogen	0	single (1x10+9)	As used for Zone 1 DQRA (Reference 7)	uniform (0.5, 2)	As used for Zone 1 DQRA (Reference 7)	Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	Results from 2016 ground investigation
Arsenic	0	single (1x10+9)		uniform (25, 250)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Benzene (o)	0	uniform (0.003, 1)		single (67.6)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Cadmium	0	single (1x10+9)		uniform (1.6, 1500)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Chloride	0	single (1x10+9)		single (0)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Formaldehyde (o)	0	single (0.383)		single (3.6)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Mecoprop (o)	0	uniform (0.137, 1)		single (12.9)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Mercury	0	single (1x10+9)		uniform (450, 3835)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Nickel	0	single (1x10+9)		uniform (20, 800)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Phenol (o)	0	uniform (0.02, 2.5)		single (83.2)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	
Zinc	0	single (1x10+9)		uniform (1, 600)		Uniform (0.0002,0.0159)	Uniform (0.001,0.0039)	

Appendix E. Zone 4 specific input parameters and results

LANDFILL WASTE:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Distribution		triangular	triangular	triangular	triangular	triangular	triangular	triangular	triangular
Landfill waste leaching test concentration Minimum	mg/L	0.05	0.0025	0.47	0.0001	0.001	0.003	0.001	0.0025
Landfill waste leaching test concentration Likely	mg/L	5	0.044	27	0.1	0.011	0.127	0.03	0.039
Landfill waste leaching test concentration Maximum	mg/L	10	0.224	99	1	0.14	0.605	0.1	0.078

DIMENSIONS OF ZONE:

Parameter	Units	Saturated Waste	Unsaturated Waste	Total for Zone
Width (perpendicular to groundwater flow)	m	200	200	200
Length (in direction of groundwater flow)	m	130	170	300
Area	m^2	26,000	34,000	60,000
Waste thickness	m	2.5	10	-

CONTAMINANTS:

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Contaminants Organic Carbon Water Partition Coefficient, Koc	L/kg	-	-	-	3.60E+00	1.29E+01	-	8.32E+01	-
Attenuation partition coefficient Kd Distribution		uniform	uniform	constant	-	-	uniform	-	uniform

Parameter	Units	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
Attenuation partition coefficient Kd Minimum	L/kg	0.5	25	0	-	-	20	-	1
Attenuation partition coefficient Kd Maximum	L/kg	2	125	-	-	-	400	-	300
Attenuation half-life distribution		constant	constant	constant	constant	uniform	constant	uniform	constant
Attenuation half-life Minimum	days	No Decay	No Decay	No Decay	139.8	50.01	No Decay	7.3	No Decay
Attenuation half-life Maximum	days	-	-	-	-	365	-	912.5	-
Contaminants free water diffusion coefficient	m^2/s	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09

HYDROGEOLOGY:

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology unit thickness distribution		uniform	constant	constant
Hydrogeology unit thickness Minimum	m	5	20	2.5
Hydrogeology unit thickness Maximum	m	10		
Hydrogeology hydraulic conductivity distribution		triangular	triangular	triangular
Hydrogeology hydraulic conductivity Minimum	m/s	1.16E-06	3.25E-08	1.16E-06
Hydrogeology hydraulic conductivity Likely	m/s	2.84E-04	0.0000128	2.84E-04
Hydrogeology hydraulic conductivity Maximum	m/s	3.76E-04	0.0000625	3.76E-04

Parameter	Units	Sand and Gravel	Limestone	Unsaturated sand and gravel
Hydrogeology head	m	80.5	78	-
Hydrogeology hydraulic gradient distribution		uniform	uniform	constant
Hydrogeology hydraulic gradient Minimum	[-]	0.003	0.002	1
Hydrogeology hydraulic gradient Maximum	[-]	0.004	0.003	
Hydrogeology porosity distribution		uniform	uniform	constant
Hydrogeology porosity Minimum	[-]	0.31	0.01	0.2
Hydrogeology porosity Maximum	[-]	0.46	0.1	
Hydrogeology tortuosity	[-]	5	5	5
Distribution		constant	constant	constant

ATTENUATION

Parameter	Units	Sand and Gravel	Limestone	Unsat SandG
Attenuation dry bulk density	kg/m3	1590	2265	1590
Attenuation fraction organic carbon distribution		triangular	uniform	triangular
Attenuation fraction organic carbon Minimum	[-]	0.001	0.001	0.001
Attenuation fraction organic carbon Likely	[-]	0.002		0.002
Attenuation fraction organic carbon Maximum	[-]	0.024	0.016	0.024

MODEL RESULTS

Saturated Waste

Uncapped 50 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	4.75E+00	7.86E-02	3.81E+01	3.02E-01	4.30E-02	2.07E-01	3.65E-02	3.73E-02
2	4.43E+00	7.33E-02	3.55E+01	2.82E-01	4.01E-02	1.93E-01	3.40E-02	3.48E-02
4	3.85E+00	6.37E-02	3.09E+01	2.45E-01	3.48E-02	1.67E-01	2.96E-02	3.02E-02
6	3.35E+00	5.54E-02	2.68E+01	2.13E-01	3.03E-02	1.46E-01	2.57E-02	2.63E-02
8	2.91E+00	4.81E-02	2.33E+01	1.85E-01	2.63E-02	1.27E-01	2.24E-02	2.28E-02
10	2.53E+00	4.19E-02	2.03E+01	1.61E-01	2.29E-02	1.10E-01	1.95E-02	1.99E-02
20	1.26E+00	2.08E-02	1.01E+01	7.99E-02	1.14E-02	5.46E-02	9.66E-03	9.86E-03
30	6.24E-01	1.03E-02	5.00E+00	3.97E-02	5.65E-03	2.71E-02	4.80E-03	4.90E-03
40	3.10E-01	5.13E-03	2.48E+00	1.97E-02	2.80E-03	1.35E-02	2.38E-03	2.43E-03
50	1.54E-01	2.55E-03	1.23E+00	9.78E-03	1.39E-03	6.69E-03	1.18E-03	1.21E-03
60	7.64E-02	1.26E-03	6.12E-01	4.86E-03	6.91E-04	3.32E-03	5.87E-04	6.00E-04
70	3.79E-02	6.28E-04	3.04E-01	2.41E-03	3.43E-04	1.65E-03	2.92E-04	2.98E-04
80	1.88E-02	3.12E-04	1.51E-01	1.20E-03	1.71E-04	8.19E-04	1.45E-04	1.48E-04
100	4.64E-03	7.69E-05	3.72E-02	2.95E-04	4.20E-05	2.02E-04	3.57E-05	3.65E-05
150	1.40E-04	2.32E-06	1.12E-03	8.92E-06	1.27E-06	6.10E-06	1.08E-06	1.10E-06
250	1.15E-07	1.90E-09	9.21E-07	7.31E-09	1.04E-09	5.00E-09	8.83E-10	9.02E-10
500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Capped 50 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	4.52E+00	8.05E-02	3.62E+01	3.15E-01	4.09E-02	2.14E-01	3.81E-02	3.49E-02
2	4.47E+00	7.96E-02	3.57E+01	3.12E-01	4.05E-02	2.12E-01	3.76E-02	3.45E-02
4	4.36E+00	7.77E-02	3.49E+01	3.05E-01	3.95E-02	2.07E-01	3.67E-02	3.37E-02
6	4.26E+00	7.59E-02	3.41E+01	2.97E-01	3.86E-02	2.02E-01	3.59E-02	3.29E-02
8	4.16E+00	7.42E-02	3.33E+01	2.91E-01	3.77E-02	1.97E-01	3.51E-02	3.22E-02
10	4.07E+00	7.25E-02	3.25E+01	2.84E-01	3.69E-02	1.93E-01	3.42E-02	3.14E-02
20	3.62E+00	6.44E-02	2.89E+01	2.52E-01	3.28E-02	1.71E-01	3.05E-02	2.80E-02
30	3.22E+00	5.73E-02	2.57E+01	2.25E-01	2.92E-02	1.52E-01	2.71E-02	2.49E-02
40	2.86E+00	5.10E-02	2.29E+01	2.00E-01	2.59E-02	1.36E-01	2.41E-02	2.21E-02
50	2.55E+00	4.53E-02	2.04E+01	1.78E-01	2.31E-02	1.21E-01	2.14E-02	1.97E-02
60	2.26E+00	4.03E-02	1.81E+01	1.58E-01	2.05E-02	1.07E-01	1.91E-02	1.75E-02
70	2.01E+00	3.59E-02	1.61E+01	1.41E-01	1.82E-02	9.54E-02	1.70E-02	1.56E-02
80	1.79E+00	3.19E-02	1.43E+01	1.25E-01	1.62E-02	8.48E-02	1.51E-02	1.38E-02
100	1.42E+00	2.52E-02	1.13E+01	9.88E-02	1.28E-02	6.71E-02	1.19E-02	1.09E-02
150	7.88E-01	1.40E-02	6.30E+00	5.50E-02	7.14E-03	3.73E-02	6.64E-03	6.09E-03
250	2.44E-01	4.35E-03	1.95E+00	1.70E-02	2.21E-03	1.16E-02	2.06E-03	1.89E-03
500	1.30E-02	2.32E-04	1.04E-01	9.09E-04	1.18E-04	6.17E-04	1.10E-04	1.01E-04
750	6.96E-04	1.24E-05	5.56E-03	4.85E-05	6.30E-06	3.30E-05	5.86E-06	5.37E-06
1000	3.71E-05	6.61E-07	2.97E-04	2.59E-06	3.36E-07	1.76E-06	3.12E-07	2.87E-07
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Uncapped 95 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	7.69E+00	1.67E-01	7.47E+01	7.14E-01	1.03E-01	4.37E-01	7.60E-02	6.26E-02
2	7.17E+00	1.56E-01	6.96E+01	6.66E-01	9.61E-02	4.08E-01	7.09E-02	5.84E-02
4	6.23E+00	1.35E-01	6.05E+01	5.79E-01	8.35E-02	3.54E-01	6.16E-02	5.07E-02
6	5.42E+00	1.18E-01	5.26E+01	5.04E-01	7.26E-02	3.08E-01	5.36E-02	4.41E-02
8	4.71E+00	1.02E-01	4.57E+01	4.38E-01	6.31E-02	2.68E-01	4.66E-02	3.83E-02
10	4.09E+00	8.89E-02	3.98E+01	3.81E-01	5.49E-02	2.33E-01	4.05E-02	3.33E-02
20	2.03E+00	4.41E-02	1.97E+01	1.89E-01	2.72E-02	1.16E-01	2.01E-02	1.66E-02
30	1.01E+00	2.19E-02	9.81E+00	9.38E-02	1.35E-02	5.74E-02	9.99E-03	8.22E-03
40	5.01E-01	1.09E-02	4.87E+00	4.66E-02	6.72E-03	2.85E-02	4.96E-03	4.08E-03
50	2.49E-01	5.41E-03	2.42E+00	2.31E-02	3.34E-03	1.42E-02	2.46E-03	2.03E-03
60	1.24E-01	2.68E-03	1.20E+00	1.15E-02	1.66E-03	7.03E-03	1.22E-03	1.01E-03
70	6.14E-02	1.33E-03	5.96E-01	5.71E-03	8.23E-04	3.49E-03	6.07E-04	5.00E-04
80	3.05E-02	6.62E-04	2.96E-01	2.83E-03	4.09E-04	1.73E-03	3.02E-04	2.48E-04
100	7.52E-03	1.63E-04	7.30E-02	6.99E-04	1.01E-04	4.27E-04	7.44E-05	6.12E-05
150	2.27E-04	4.93E-06	2.20E-03	2.11E-05	3.04E-06	1.29E-05	2.25E-06	1.85E-06
250	1.86E-07	4.04E-09	1.81E-06	1.73E-08	2.49E-09	1.06E-08	1.84E-09	1.51E-09
500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
750	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Capped 95 th Percentile Concentrations in mg/L in Haz Subs

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	7.80E+00	1.73E-01	7.56E+01	7.49E-01	1.03E-01	4.49E-01	7.65E-02	6.13E-02
2	7.71E+00	1.71E-01	7.47E+01	7.40E-01	1.02E-01	4.43E-01	7.56E-02	6.06E-02
4	7.53E+00	1.67E-01	7.30E+01	7.23E-01	9.94E-02	4.33E-01	7.38E-02	5.92E-02
6	7.36E+00	1.63E-01	7.13E+01	7.06E-01	9.71E-02	4.23E-01	7.21E-02	5.78E-02
8	7.19E+00	1.59E-01	6.97E+01	6.90E-01	9.48E-02	4.13E-01	7.04E-02	5.65E-02
10	7.02E+00	1.56E-01	6.80E+01	6.74E-01	9.26E-02	4.04E-01	6.88E-02	5.52E-02
20	6.24E+00	1.38E-01	6.05E+01	5.99E-01	8.24E-02	3.59E-01	6.12E-02	4.91E-02
30	5.55E+00	1.23E-01	5.38E+01	5.33E-01	7.33E-02	3.19E-01	5.44E-02	4.36E-02
40	4.94E+00	1.10E-01	4.79E+01	4.74E-01	6.52E-02	2.84E-01	4.84E-02	3.88E-02
50	4.39E+00	9.74E-02	4.26E+01	4.22E-01	5.80E-02	2.53E-01	4.31E-02	3.45E-02
60	3.91E+00	8.66E-02	3.79E+01	3.75E-01	5.16E-02	2.25E-01	3.83E-02	3.07E-02
70	3.48E+00	7.71E-02	3.37E+01	3.34E-01	4.59E-02	2.00E-01	3.41E-02	2.73E-02
80	3.09E+00	6.85E-02	3.00E+01	2.97E-01	4.08E-02	1.78E-01	3.03E-02	2.43E-02
100	2.45E+00	5.42E-02	2.37E+01	2.35E-01	3.23E-02	1.41E-01	2.40E-02	1.92E-02
150	1.36E+00	3.02E-02	1.32E+01	1.31E-01	1.80E-02	7.82E-02	1.33E-02	1.07E-02
250	4.21E-01	9.34E-03	4.08E+00	4.04E-02	5.56E-03	2.42E-02	4.13E-03	3.31E-03
500	2.25E-02	4.99E-04	2.18E-01	2.16E-03	2.97E-04	1.29E-03	2.20E-04	1.77E-04
750	1.20E-03	2.66E-05	1.16E-02	1.15E-04	1.58E-05	6.90E-05	1.18E-05	9.43E-06
1000	6.41E-05	1.42E-06	6.21E-04	6.15E-06	8.45E-07	3.68E-06	6.28E-07	5.03E-07
2000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Overburden

Uncapped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	3.01E-14	3.83E-19	1.47E-22	0.00E+00	0.00E+00	0.00E+00
2	2.52E-08	0.00E+00	2.75E+00	3.01E-03	1.69E-04	0.00E+00	4.07E-08	0.00E+00
4	1.09E-02	0.00E+00	8.29E+00	5.07E-03	6.76E-04	0.00E+00	9.90E-05	0.00E+00
6	1.31E-01	0.00E+00	1.08E+01	4.44E-03	6.14E-04	0.00E+00	2.82E-04	0.00E+00
8	3.35E-01	0.00E+00	1.13E+01	3.86E-03	5.37E-04	0.00E+00	3.40E-04	0.00E+00
10	4.76E-01	1.27E-38	1.06E+01	3.36E-03	4.67E-04	0.00E+00	3.37E-04	0.00E+00
20	5.90E-01	1.08E-23	5.80E+00	1.67E-03	2.32E-04	0.00E+00	1.82E-04	1.15E-34
30	4.98E-01	1.64E-18	2.93E+00	8.28E-04	1.15E-04	1.62E-34	9.02E-05	4.62E-27
40	4.04E-01	5.42E-14	1.46E+00	4.11E-04	5.71E-05	7.42E-31	4.48E-05	2.05E-22
50	3.18E-01	2.12E-11	7.26E-01	2.04E-04	2.84E-05	1.16E-24	2.22E-05	2.12E-20
60	2.24E-01	1.01E-09	3.61E-01	1.01E-04	1.41E-05	1.51E-21	1.10E-05	8.90E-18
70	1.37E-01	1.60E-08	1.79E-01	5.03E-05	7.00E-06	8.91E-20	5.48E-06	1.85E-15
80	7.90E-02	1.20E-07	8.90E-02	2.50E-05	3.47E-06	2.18E-18	2.72E-06	9.83E-14
100	2.33E-02	1.69E-06	2.19E-02	6.16E-06	8.57E-07	1.03E-14	6.72E-07	2.56E-11
150	8.00E-04	5.36E-05	6.62E-04	1.86E-07	2.59E-08	3.60E-10	2.03E-08	3.35E-08
250	7.41E-07	3.38E-04	5.55E-07	1.52E-10	2.12E-11	1.20E-06	1.71E-11	6.10E-06
500	2.01E-10	2.89E-04	0.00E+00	0.00E+00	0.00E+00	1.77E-04	0.00E+00	6.84E-05
750	0.00E+00	1.81E-04	0.00E+00	0.00E+00	0.00E+00	3.02E-04	0.00E+00	7.64E-05
1000	0.00E+00	1.30E-04	0.00E+00	0.00E+00	0.00E+00	3.25E-04	0.00E+00	6.45E-05
2000	0.00E+00	7.77E-05	0.00E+00	0.00E+00	0.00E+00	1.78E-04	0.00E+00	2.54E-05

Capped 50 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	5.51E-15	1.05E-19	9.24E-24	0.00E+00	0.00E+00	0.00E+00
2	2.26E-09	0.00E+00	6.80E-01	7.79E-04	4.38E-05	0.00E+00	1.68E-08	0.00E+00
4	1.89E-03	0.00E+00	2.19E+00	1.51E-03	2.00E-04	0.00E+00	3.17E-05	0.00E+00
6	3.04E-02	0.00E+00	2.49E+00	1.48E-03	2.01E-04	0.00E+00	9.42E-05	0.00E+00
8	8.64E-02	0.00E+00	2.69E+00	1.44E-03	1.97E-04	0.00E+00	1.23E-04	0.00E+00
10	1.39E-01	0.00E+00	2.99E+00	1.41E-03	1.92E-04	0.00E+00	1.32E-04	0.00E+00
20	2.45E-01	2.39E-24	3.94E+00	1.25E-03	1.71E-04	0.00E+00	1.23E-04	1.43E-35
30	2.42E-01	2.16E-19	3.66E+00	1.11E-03	1.52E-04	3.03E-34	1.09E-04	4.22E-28
40	2.26E-01	8.05E-15	3.27E+00	9.91E-04	1.35E-04	6.46E-31	9.72E-05	2.58E-24
50	2.12E-01	3.77E-12	2.91E+00	8.81E-04	1.20E-04	2.14E-26	8.64E-05	5.66E-21
60	2.07E-01	2.06E-10	2.59E+00	7.84E-04	1.07E-04	2.72E-22	7.69E-05	1.01E-18
70	2.03E-01	3.54E-09	2.30E+00	6.97E-04	9.52E-05	1.05E-20	6.84E-05	2.30E-16
80	1.98E-01	2.95E-08	2.05E+00	6.20E-04	8.47E-05	7.01E-20	6.08E-05	1.34E-14
100	1.92E-01	5.64E-07	1.62E+00	4.91E-04	6.70E-05	3.51E-16	4.81E-05	3.98E-12
150	1.60E-01	2.33E-05	9.02E-01	2.73E-04	3.73E-05	2.83E-11	2.68E-05	7.59E-09
250	7.34E-02	3.10E-04	2.79E-01	8.45E-05	1.15E-05	2.33E-07	8.29E-06	2.94E-06
500	4.65E-03	5.37E-04	1.49E-02	4.51E-06	6.16E-07	1.14E-04	4.43E-07	7.64E-05
750	2.54E-04	2.67E-04	7.96E-04	2.41E-07	3.29E-08	3.36E-04	2.36E-08	1.06E-04
1000	1.36E-05	9.02E-05	4.25E-05	1.29E-08	1.76E-09	3.86E-04	1.26E-09	9.25E-05
2000	1.04E-10	1.40E-05	0.00E+00	0.00E+00	0.00E+00	2.15E-04	0.00E+00	2.33E-05

Uncapped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	5.30E-29	0.00E+00	7.53E-09	2.17E-12	2.41E-15	0.00E+00	3.09E-22	0.00E+00
2	8.98E-04	0.00E+00	8.59E+00	1.54E-02	2.41E-03	0.00E+00	3.67E-04	0.00E+00
4	2.96E-01	1.33E-32	1.73E+01	1.78E-02	4.86E-03	1.03E-40	3.38E-03	2.87E-27
6	7.49E-01	2.18E-26	2.19E+01	1.55E-02	4.42E-03	6.98E-34	3.86E-03	1.66E-20
8	9.92E-01	3.16E-23	2.31E+01	1.35E-02	3.89E-03	4.78E-27	3.78E-03	2.16E-16
10	1.06E+00	3.02E-20	2.22E+01	1.18E-02	3.39E-03	8.81E-25	3.29E-03	4.18E-13
20	1.08E+00	4.48E-11	1.36E+01	5.83E-03	1.68E-03	3.33E-14	1.72E-03	5.08E-07
30	9.38E-01	1.12E-07	7.40E+00	2.90E-03	8.35E-04	1.46E-09	8.55E-04	3.52E-05
40	7.68E-01	3.80E-06	3.88E+00	1.44E-03	4.15E-04	2.27E-07	4.25E-04	1.75E-04
50	6.33E-01	3.03E-05	1.94E+00	7.14E-04	2.06E-04	4.83E-06	2.11E-04	3.98E-04
60	5.40E-01	1.15E-04	9.63E-01	3.55E-04	1.02E-04	3.06E-05	1.05E-04	5.54E-04
70	4.54E-01	2.57E-04	4.86E-01	1.76E-04	5.08E-05	1.17E-04	5.20E-05	7.57E-04
80	3.67E-01	4.61E-04	2.41E-01	8.75E-05	2.52E-05	2.80E-04	2.58E-05	7.64E-04
100	2.36E-01	1.09E-03	5.95E-02	2.16E-05	6.22E-06	9.11E-04	6.37E-06	8.83E-04
150	5.89E-02	1.91E-03	1.80E-03	6.51E-07	1.88E-07	2.35E-03	1.92E-07	7.15E-04
250	1.76E-03	1.50E-03	1.59E-06	5.32E-10	1.54E-10	2.39E-03	1.58E-10	5.37E-04
500	1.36E-07	9.91E-04	0.00E+00	0.00E+00	0.00E+00	1.76E-03	0.00E+00	3.23E-04
750	4.62E-10	6.69E-04	0.00E+00	0.00E+00	0.00E+00	1.43E-03	0.00E+00	2.35E-04
1000	2.52E-10	5.01E-04	0.00E+00	0.00E+00	0.00E+00	1.19E-03	0.00E+00	1.85E-04
2000	0.00E+00	2.59E-04	0.00E+00	0.00E+00	0.00E+00	6.55E-04	0.00E+00	9.57E-05

Capped 95 th Percentile Concentrations in mg/L in Overburden

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	1.59E-29	0.00E+00	3.74E-09	1.51E-12	1.03E-15	0.00E+00	2.32E-23	0.00E+00
2	2.27E-04	0.00E+00	2.12E+00	4.05E-03	5.18E-04	0.00E+00	8.01E-05	0.00E+00
4	7.70E-02	4.27E-32	5.25E+00	5.10E-03	1.21E-03	0.00E+00	7.75E-04	9.70E-28
6	2.02E-01	4.82E-27	6.03E+00	4.98E-03	1.19E-03	3.02E-33	9.86E-04	3.56E-22
8	2.95E-01	1.40E-22	6.54E+00	4.87E-03	1.16E-03	6.79E-31	9.96E-04	6.28E-18
10	3.62E-01	1.59E-20	7.08E+00	4.75E-03	1.14E-03	1.77E-25	9.78E-04	2.11E-14
20	5.07E-01	2.70E-11	9.97E+00	4.23E-03	1.01E-03	1.29E-15	8.73E-04	3.74E-08
30	5.64E-01	5.00E-08	1.01E+01	3.76E-03	8.99E-04	8.49E-11	7.77E-04	3.53E-06
40	5.60E-01	1.98E-06	9.29E+00	3.34E-03	8.00E-04	1.90E-08	6.91E-04	3.43E-05
50	5.44E-01	1.56E-05	8.77E+00	2.97E-03	7.11E-04	4.59E-07	6.14E-04	1.38E-04
60	5.46E-01	6.06E-05	7.80E+00	2.65E-03	6.33E-04	3.75E-06	5.46E-04	3.11E-04
70	5.41E-01	1.45E-04	6.98E+00	2.35E-03	5.63E-04	1.98E-05	4.86E-04	4.65E-04
80	5.27E-01	2.74E-04	6.21E+00	2.09E-03	5.01E-04	6.08E-05	4.32E-04	6.25E-04
100	5.22E-01	6.81E-04	4.91E+00	1.66E-03	3.96E-04	2.47E-04	3.42E-04	7.55E-04
150	4.27E-01	1.74E-03	2.73E+00	9.21E-04	2.20E-04	1.29E-03	1.90E-04	9.54E-04
250	2.55E-01	2.24E-03	8.47E-01	2.85E-04	6.82E-05	3.05E-03	5.89E-05	7.57E-04
500	2.48E-02	1.70E-03	4.52E-02	1.52E-05	3.64E-06	3.14E-03	3.15E-06	5.24E-04
750	1.45E-03	1.32E-03	2.41E-03	8.13E-07	1.94E-07	2.31E-03	1.68E-07	4.19E-04
1000	7.74E-05	1.03E-03	1.29E-04	4.34E-08	1.04E-08	2.08E-03	8.96E-09	3.28E-04
2000	8.06E-10	3.54E-04	0.00E+00	0.00E+00	0.00E+00	1.25E-03	0.00E+00	1.87E-04

Overburden at the River Morell

Uncapped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	6.36E-17	3.84E-20	6.57E-26	0.00E+00	0.00E+00	0.00E+00
2	1.11E-09	0.00E+00	1.86E+00	1.77E-03	8.18E-05	0.00E+00	4.09E-09	0.00E+00
4	3.53E-03	0.00E+00	7.90E+00	3.76E-03	4.75E-04	0.00E+00	4.30E-05	0.00E+00
6	7.54E-02	0.00E+00	1.05E+01	3.28E-03	4.51E-04	0.00E+00	1.66E-04	0.00E+00
8	2.35E-01	0.00E+00	1.11E+01	2.86E-03	3.95E-04	0.00E+00	2.37E-04	0.00E+00
10	3.89E-01	8.45E-41	1.07E+01	2.48E-03	3.45E-04	0.00E+00	2.28E-04	0.00E+00
20	5.84E-01	1.47E-26	5.89E+00	1.23E-03	1.72E-04	0.00E+00	1.28E-04	2.12E-36
30	5.03E-01	3.52E-20	2.99E+00	6.12E-04	8.52E-05	7.73E-36	6.40E-05	3.33E-31
40	4.15E-01	4.83E-16	1.49E+00	3.04E-04	4.23E-05	2.23E-31	3.19E-05	1.61E-24
50	3.30E-01	5.49E-13	7.39E-01	1.51E-04	2.10E-05	3.33E-27	1.58E-05	4.90E-22
60	2.35E-01	4.88E-11	3.67E-01	7.50E-05	1.04E-05	4.11E-24	7.86E-06	2.81E-20
70	1.48E-01	1.19E-09	1.82E-01	3.72E-05	5.18E-06	1.16E-21	3.90E-06	1.26E-17
80	8.62E-02	1.30E-08	9.04E-02	1.85E-05	2.57E-06	6.42E-20	1.94E-06	1.26E-15
100	2.61E-02	3.12E-07	2.23E-02	4.56E-06	6.34E-07	6.84E-17	4.78E-07	7.80E-13
150	9.22E-04	1.79E-05	6.73E-04	1.38E-07	1.92E-08	1.30E-11	1.44E-08	3.45E-09
250	8.61E-07	2.26E-04	5.69E-07	1.12E-10	1.57E-11	1.69E-07	1.23E-11	1.75E-06
500	2.02E-10	2.94E-04	0.00E+00	0.00E+00	0.00E+00	8.63E-05	0.00E+00	5.18E-05
750	0.00E+00	2.10E-04	0.00E+00	0.00E+00	0.00E+00	2.49E-04	0.00E+00	6.71E-05
1000	0.00E+00	1.47E-04	0.00E+00	0.00E+00	0.00E+00	2.92E-04	0.00E+00	6.71E-05
2000	0.00E+00	8.25E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-04	0.00E+00	2.90E-05

Capped 50 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	1.27E-17	8.32E-21	3.78E-26	0.00E+00	0.00E+00	0.00E+00
2	7.61E-11	0.00E+00	4.46E-01	4.60E-04	2.15E-05	0.00E+00	2.11E-09	0.00E+00
4	6.19E-04	0.00E+00	2.10E+00	1.08E-03	1.41E-04	0.00E+00	1.46E-05	0.00E+00
6	1.57E-02	0.00E+00	2.39E+00	1.06E-03	1.50E-04	0.00E+00	5.78E-05	0.00E+00
8	5.75E-02	0.00E+00	2.63E+00	1.04E-03	1.46E-04	0.00E+00	8.62E-05	0.00E+00
10	1.08E-01	6.80E-40	2.92E+00	1.01E-03	1.43E-04	0.00E+00	9.19E-05	0.00E+00
20	2.31E-01	1.89E-27	3.93E+00	9.02E-04	1.27E-04	0.00E+00	8.75E-05	5.75E-39
30	2.40E-01	9.83E-21	3.67E+00	8.02E-04	1.13E-04	2.01E-36	7.92E-05	3.89E-32
40	2.27E-01	6.79E-17	3.28E+00	7.13E-04	1.00E-04	2.88E-32	7.04E-05	3.26E-26
50	2.14E-01	8.33E-14	2.92E+00	6.34E-04	8.93E-05	5.93E-27	6.26E-05	1.46E-22
60	2.08E-01	9.30E-12	2.60E+00	5.64E-04	7.94E-05	2.81E-24	5.57E-05	8.57E-21
70	2.03E-01	2.47E-10	2.31E+00	5.02E-04	7.06E-05	2.67E-22	4.95E-05	1.45E-18
80	1.99E-01	2.93E-09	2.05E+00	4.46E-04	6.28E-05	6.56E-21	4.41E-05	1.57E-16
100	1.93E-01	8.87E-08	1.63E+00	3.53E-04	4.97E-05	1.34E-18	3.49E-05	1.12E-13
150	1.61E-01	7.46E-06	9.04E-01	1.96E-04	2.77E-05	8.04E-13	1.94E-05	7.13E-10
250	7.45E-02	1.79E-04	2.80E-01	6.08E-05	8.56E-06	2.78E-08	6.01E-06	7.44E-07
500	4.73E-03	4.96E-04	1.50E-02	3.25E-06	4.57E-07	4.43E-05	3.21E-07	5.09E-05
750	2.59E-04	3.14E-04	7.98E-04	1.73E-07	2.44E-08	2.20E-04	1.71E-08	8.12E-05
1000	1.39E-05	1.30E-04	4.26E-05	9.25E-09	1.30E-09	3.18E-04	9.13E-10	8.59E-05
2000	1.11E-10	2.00E-05	0.00E+00	0.00E+00	0.00E+00	2.41E-04	0.00E+00	3.06E-05

Uncapped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	3.02E-29	0.00E+00	2.02E-10	3.07E-14	1.42E-17	0.00E+00	4.84E-24	0.00E+00
2	1.83E-04	0.00E+00	6.66E+00	1.04E-02	1.50E-03	0.00E+00	1.76E-04	0.00E+00
4	1.91E-01	3.28E-34	1.68E+01	1.39E-02	4.06E-03	0.00E+00	2.60E-03	2.78E-31
6	6.01E-01	1.08E-28	2.14E+01	1.21E-02	3.72E-03	8.41E-35	3.36E-03	2.77E-22
8	8.81E-01	1.80E-24	2.31E+01	1.05E-02	3.30E-03	1.70E-30	3.20E-03	7.10E-19
10	1.01E+00	6.42E-22	2.22E+01	9.14E-03	2.89E-03	4.54E-26	2.89E-03	5.97E-15
20	1.07E+00	1.20E-12	1.39E+01	4.54E-03	1.43E-03	2.38E-16	1.50E-03	6.84E-08
30	9.51E-01	1.06E-08	7.56E+00	2.25E-03	7.11E-04	5.99E-11	7.44E-04	9.83E-06
40	8.00E-01	7.47E-07	3.99E+00	1.12E-03	3.53E-04	2.21E-08	3.69E-04	8.51E-05
50	6.49E-01	8.01E-06	2.03E+00	5.56E-04	1.75E-04	7.23E-07	1.83E-04	2.26E-04
60	5.61E-01	3.89E-05	1.02E+00	2.76E-04	8.71E-05	7.01E-06	9.11E-05	4.29E-04
70	4.71E-01	1.15E-04	5.14E-01	1.37E-04	4.33E-05	3.20E-05	4.52E-05	4.94E-04
80	3.85E-01	2.28E-04	2.55E-01	6.81E-05	2.15E-05	1.01E-04	2.25E-05	6.73E-04
100	2.48E-01	5.93E-04	6.30E-02	1.68E-05	5.30E-06	4.28E-04	5.54E-06	7.99E-04
150	6.96E-02	1.57E-03	1.90E-03	5.07E-07	1.60E-07	1.81E-03	1.67E-07	6.86E-04
250	2.64E-03	1.42E-03	1.66E-06	4.14E-10	1.31E-10	1.99E-03	1.41E-10	5.20E-04
500	3.40E-07	9.49E-04	0.00E+00	0.00E+00	0.00E+00	1.75E-03	0.00E+00	3.13E-04
750	4.85E-10	6.78E-04	0.00E+00	0.00E+00	0.00E+00	1.41E-03	0.00E+00	2.19E-04
1000	2.67E-10	5.15E-04	0.00E+00	0.00E+00	0.00E+00	1.12E-03	0.00E+00	1.81E-04
2000	0.00E+00	2.69E-04	0.00E+00	0.00E+00	0.00E+00	6.51E-04	0.00E+00	9.71E-05

Capped 95 th Percentile Concentrations in mg/L in River Morell

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	6.76E-30	0.00E+00	1.01E-10	2.58E-14	8.69E-18	0.00E+00	1.25E-24	0.00E+00
2	4.77E-05	0.00E+00	1.63E+00	2.88E-03	3.36E-04	0.00E+00	3.63E-05	0.00E+00
4	4.89E-02	6.14E-35	4.91E+00	3.95E-03	9.65E-04	0.00E+00	5.84E-04	1.74E-32
6	1.63E-01	1.10E-27	5.88E+00	3.86E-03	9.72E-04	1.16E-36	8.51E-04	1.59E-24
8	2.49E-01	7.15E-25	6.37E+00	3.77E-03	9.50E-04	1.29E-31	8.65E-04	1.15E-20
10	3.21E-01	4.74E-22	6.87E+00	3.69E-03	9.28E-04	1.22E-30	8.52E-04	2.22E-16
20	4.73E-01	8.45E-13	9.80E+00	3.28E-03	8.25E-04	7.86E-18	7.60E-04	4.68E-09
30	5.35E-01	5.19E-09	1.00E+01	2.92E-03	7.34E-04	2.99E-12	6.76E-04	8.89E-07
40	5.52E-01	3.58E-07	9.27E+00	2.59E-03	6.53E-04	1.58E-09	6.01E-04	1.13E-05
50	5.45E-01	4.29E-06	8.65E+00	2.31E-03	5.81E-04	6.40E-08	5.35E-04	6.18E-05
60	5.42E-01	2.09E-05	7.86E+00	2.05E-03	5.16E-04	7.30E-07	4.76E-04	1.65E-04
70	5.43E-01	6.46E-05	7.04E+00	1.82E-03	4.59E-04	4.14E-06	4.23E-04	3.19E-04
80	5.33E-01	1.35E-04	6.26E+00	1.62E-03	4.09E-04	1.74E-05	3.76E-04	4.40E-04
100	5.20E-01	3.80E-04	4.95E+00	1.28E-03	3.23E-04	1.10E-04	2.98E-04	6.25E-04
150	4.33E-01	1.27E-03	2.76E+00	7.14E-04	1.80E-04	7.57E-04	1.66E-04	8.54E-04
250	2.62E-01	1.96E-03	8.54E-01	2.21E-04	5.57E-05	2.50E-03	5.13E-05	7.02E-04
500	2.67E-02	1.62E-03	4.56E-02	1.18E-05	2.97E-06	2.94E-03	2.74E-06	5.22E-04
750	1.54E-03	1.26E-03	2.43E-03	6.30E-07	1.59E-07	2.31E-03	1.46E-07	3.79E-04
1000	8.21E-05	9.63E-04	1.30E-04	3.36E-08	8.47E-09	1.89E-03	7.80E-09	3.17E-04
2000	8.30E-10	3.80E-04	0.00E+00	0.00E+00	0.00E+00	1.18E-03	0.00E+00	1.94E-04

Limestone Aquifer

Uncapped 50th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	2.36E-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	6.32E-03	1.65E-11	4.00E-25	0.00E+00	0.00E+00	0.00E+00
4	0.00E+00	0.00E+00	2.72E+00	3.58E-06	9.14E-12	0.00E+00	2.05E-38	0.00E+00
6	5.49E-32	0.00E+00	5.70E+00	7.94E-06	1.60E-09	0.00E+00	4.44E-31	0.00E+00
8	3.50E-29	0.00E+00	7.24E+00	7.20E-06	5.82E-09	0.00E+00	7.46E-24	0.00E+00
10	5.27E-25	0.00E+00	8.06E+00	6.27E-06	9.98E-09	0.00E+00	2.84E-20	0.00E+00
20	1.02E-11	0.00E+00	6.32E+00	3.11E-06	6.37E-09	0.00E+00	1.29E-14	0.00E+00
30	1.81E-07	0.00E+00	3.53E+00	1.55E-06	3.17E-09	0.00E+00	1.23E-13	0.00E+00
40	1.92E-05	0.00E+00	1.87E+00	7.68E-07	1.57E-09	0.00E+00	2.03E-13	0.00E+00
50	2.90E-04	0.00E+00	9.56E-01	3.81E-07	7.81E-10	0.00E+00	1.62E-13	0.00E+00
60	1.65E-03	0.00E+00	4.79E-01	1.89E-07	3.88E-10	0.00E+00	8.86E-14	0.00E+00
70	5.51E-03	0.00E+00	2.39E-01	9.40E-08	1.93E-10	0.00E+00	4.56E-14	0.00E+00
80	1.22E-02	0.00E+00	1.19E-01	4.67E-08	9.56E-11	0.00E+00	2.32E-14	0.00E+00
100	3.11E-02	0.00E+00	2.93E-02	1.15E-08	2.36E-11	0.00E+00	5.73E-15	0.00E+00
150	6.60E-02	0.00E+00	8.85E-04	3.48E-10	7.12E-13	0.00E+00	1.73E-16	0.00E+00
250	5.41E-02	1.53E-38	7.69E-07	2.88E-13	6.37E-16	0.00E+00	1.59E-19	0.00E+00
500	1.86E-02	7.60E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-29	2.99E-36
750	5.08E-03	2.50E-20	0.00E+00	0.00E+00	0.00E+00	1.54E-37	0.00E+00	8.20E-31
1000	1.19E-03	1.05E-15	0.00E+00	0.00E+00	0.00E+00	8.11E-33	0.00E+00	7.02E-25
2000	2.39E-06	4.40E-09	0.00E+00	0.00E+00	0.00E+00	1.78E-20	0.00E+00	1.28E-14

Capped 50th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	1.74E-03	3.66E-12	1.67E-25	0.00E+00	0.00E+00	0.00E+00
4	0.00E+00	0.00E+00	7.22E-01	8.62E-07	2.09E-12	0.00E+00	0.00E+00	0.00E+00
6	3.20E-38	0.00E+00	1.45E+00	2.13E-06	3.66E-10	0.00E+00	5.69E-30	0.00E+00
8	3.04E-31	0.00E+00	1.80E+00	2.22E-06	1.86E-09	0.00E+00	2.83E-24	0.00E+00
10	4.35E-25	0.00E+00	2.09E+00	2.17E-06	2.96E-09	0.00E+00	8.81E-21	0.00E+00
20	7.08E-13	0.00E+00	3.09E+00	1.93E-06	4.28E-09	0.00E+00	7.75E-15	0.00E+00
30	2.36E-08	0.00E+00	3.20E+00	1.72E-06	3.81E-09	0.00E+00	7.33E-14	0.00E+00
40	3.35E-06	0.00E+00	3.04E+00	1.53E-06	3.38E-09	0.00E+00	1.39E-13	0.00E+00
50	6.04E-05	0.00E+00	2.78E+00	1.36E-06	3.01E-09	0.00E+00	1.45E-13	0.00E+00
60	3.92E-04	0.00E+00	2.50E+00	1.21E-06	2.68E-09	0.00E+00	1.59E-13	0.00E+00
70	1.39E-03	0.00E+00	2.25E+00	1.08E-06	2.38E-09	0.00E+00	1.44E-13	0.00E+00
80	3.53E-03	0.00E+00	2.01E+00	9.57E-07	2.12E-09	0.00E+00	1.28E-13	0.00E+00
100	1.18E-02	0.00E+00	1.60E+00	7.57E-07	1.68E-09	0.00E+00	1.02E-13	0.00E+00
150	4.51E-02	0.00E+00	8.97E-01	4.21E-07	9.32E-10	0.00E+00	5.65E-14	0.00E+00
250	7.71E-02	0.00E+00	2.78E-01	1.31E-07	2.89E-10	0.00E+00	1.75E-14	0.00E+00
500	4.47E-02	4.57E-27	1.48E-02	6.97E-09	1.54E-11	0.00E+00	9.35E-16	1.20E-37
750	1.89E-02	2.39E-20	7.92E-04	3.72E-10	8.23E-13	1.11E-38	4.99E-17	1.10E-32
1000	6.41E-03	1.24E-15	4.23E-05	1.98E-11	4.39E-14	2.16E-33	2.66E-18	9.04E-27
2000	2.01E-05	6.50E-09	0.00E+00	0.00E+00	0.00E+00	1.29E-20	0.00E+00	1.14E-15

Uncapped 95th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	2.18E-15	3.10E-27	3.25E-38	0.00E+00	0.00E+00	0.00E+00
2	1.24E-32	0.00E+00	5.42E+00	8.86E-05	7.88E-09	0.00E+00	1.65E-24	0.00E+00
4	6.03E-21	0.00E+00	1.41E+01	1.25E-03	3.83E-05	0.00E+00	5.94E-12	0.00E+00
6	2.19E-15	0.00E+00	1.81E+01	1.15E-03	8.64E-05	0.00E+00	1.58E-08	0.00E+00
8	1.22E-10	0.00E+00	2.01E+01	1.00E-03	8.70E-05	0.00E+00	4.41E-07	0.00E+00
10	4.06E-08	0.00E+00	2.00E+01	8.73E-04	7.95E-05	0.00E+00	1.49E-06	0.00E+00
20	1.58E-03	0.00E+00	1.44E+01	4.33E-04	3.98E-05	0.00E+00	3.85E-06	0.00E+00
30	2.99E-02	0.00E+00	9.40E+00	2.15E-04	1.98E-05	0.00E+00	2.74E-06	0.00E+00
40	1.03E-01	0.00E+00	5.66E+00	1.07E-04	9.82E-06	0.00E+00	1.42E-06	0.00E+00
50	1.78E-01	2.39E-40	3.57E+00	5.31E-05	4.88E-06	0.00E+00	7.18E-07	1.34E-37
60	2.27E-01	1.04E-37	2.14E+00	2.64E-05	2.42E-06	0.00E+00	3.57E-07	6.57E-33
70	2.50E-01	6.50E-33	1.28E+00	1.31E-05	1.20E-06	0.00E+00	1.77E-07	5.83E-31
80	2.71E-01	1.22E-32	6.88E-01	6.50E-06	5.97E-07	0.00E+00	8.79E-08	4.95E-30
100	2.53E-01	2.45E-30	2.08E-01	1.60E-06	1.47E-07	1.93E-37	2.17E-08	3.25E-26
150	2.00E-01	5.90E-24	7.04E-03	4.84E-08	4.45E-09	3.02E-31	6.55E-10	1.15E-20
250	1.25E-01	6.51E-19	7.23E-06	3.97E-11	3.78E-12	1.04E-23	6.00E-13	2.39E-14
500	5.55E-02	3.65E-10	5.67E-10	0.00E+00	0.00E+00	4.40E-15	1.33E-18	2.43E-08
750	3.22E-02	1.92E-07	0.00E+00	0.00E+00	0.00E+00	1.67E-10	1.70E-22	1.53E-06
1000	2.21E-02	2.98E-06	0.00E+00	0.00E+00	0.00E+00	2.72E-08	1.31E-27	9.23E-06
2000	5.69E-03	6.10E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05	0.00E+00	3.35E-05

Capped 95th Percentile Concentrations in mg/L in Limestone Aquifer

Time(years)	Ammoniacal nitrogen	Arsenic	Chloride	Formaldehyde (o)	Mecoprop (o)	Nickel	Phenol (o)	Zinc
1	0.00E+00	0.00E+00	6.26E-16	6.62E-27	5.28E-38	0.00E+00	0.00E+00	0.00E+00
2	3.79E-36	0.00E+00	1.50E+00	3.98E-05	2.47E-09	0.00E+00	6.03E-25	0.00E+00
4	2.68E-22	0.00E+00	4.13E+00	4.37E-04	7.66E-06	0.00E+00	8.81E-13	0.00E+00
6	1.32E-16	0.00E+00	5.05E+00	4.37E-04	2.15E-05	0.00E+00	3.75E-09	0.00E+00
8	9.26E-12	0.00E+00	5.53E+00	4.27E-04	2.64E-05	0.00E+00	8.37E-08	0.00E+00
10	4.32E-09	0.00E+00	6.27E+00	4.17E-04	2.70E-05	0.00E+00	4.03E-07	0.00E+00
20	2.68E-04	0.00E+00	8.54E+00	3.71E-04	2.41E-05	0.00E+00	1.53E-06	0.00E+00
30	6.48E-03	0.00E+00	8.61E+00	3.30E-04	2.14E-05	0.00E+00	1.51E-06	0.00E+00
40	2.98E-02	0.00E+00	8.30E+00	2.93E-04	1.91E-05	0.00E+00	1.39E-06	0.00E+00
50	6.73E-02	0.00E+00	7.72E+00	2.61E-04	1.70E-05	0.00E+00	1.24E-06	2.69E-37
60	9.85E-02	3.91E-35	7.10E+00	2.32E-04	1.51E-05	0.00E+00	1.10E-06	1.27E-31
70	1.30E-01	1.34E-33	6.37E+00	2.06E-04	1.34E-05	0.00E+00	9.77E-07	3.02E-33
80	1.57E-01	2.57E-32	5.71E+00	1.84E-04	1.19E-05	0.00E+00	8.69E-07	1.45E-27
100	1.90E-01	3.97E-31	4.52E+00	1.45E-04	9.44E-06	6.37E-38	6.87E-07	2.26E-24
150	2.36E-01	1.76E-23	2.56E+00	8.08E-05	5.25E-06	4.37E-32	3.83E-07	4.81E-20
250	2.27E-01	7.14E-19	8.28E-01	2.50E-05	1.63E-06	1.34E-23	1.19E-07	7.92E-13
500	1.27E-01	2.73E-10	4.42E-02	1.34E-06	8.68E-08	1.09E-15	6.32E-09	1.75E-07
750	7.25E-02	1.53E-07	2.36E-03	7.13E-08	4.64E-09	8.66E-11	3.38E-10	5.62E-06
1000	4.64E-02	2.69E-06	1.26E-04	3.81E-09	2.47E-10	1.84E-08	1.80E-11	2.77E-05
2000	1.10E-02	9.16E-05	0.00E+00	0.00E+00	0.00E+00	1.81E-05	0.00E+00	4.52E-05

Appendix A13.1 Flood Risk Assessment

Kerdiffstown Landfill Remediation Project

Kildare County Council

Flood Risk Assessment

June 2017

JACOBS

Kerdiffstown Landfill Remediation Project

Project no:	32EW5604
Document title:	Flood Risk Assessment
Document No.:	
Revision:	1
Date:	June 2017
Client name:	Kildare County Council
Client No.:	
Project manager:	Rihanna Rose
Author:	Jennifer Johnston
File Name:	G:\JI\Sustainable Solutions\Kerdiffstown Landfill\4 - Documents\4.3 - Draft Documents\32EW5604 E EIA IED Planning\EIA\Specialists EIS\Hydrology\FRA

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Document history and status

Revision	Date	Description	By	Review	Approved
Original	March 2017	Issue for Planning	Jennifer Johnston	Mairéad Conlon	Peter Smyth
Rev 1	June 2017	Final EIAR Issue		Sharon Sugrue	Rhianna Rose

JACOBS

Glossary

Annual Exceedance Probability **Or AEP**	The probability of a flood event of a given magnitude being equalled or exceeded in any given year. For example: • a 0.1% AEP flood event has a 0.1%, or 1 in a 1000, chance of occurring or being exceeded in any given year. • a 1% AEP flood event has a 1%, or 1 in a 100, chance of occurring or being exceeded in any given year. • a 10% AEP flood event has a 10%, or 1 in a 10, chance of occurring or being exceeded in any given year.
Q_{BAR}	Mean Annual Flood

Contents

1. Introduction

Jacobs Engineering was commissioned by Kildare County Council to provide consultancy services in respect of the proposed remediation of the former Kerdiffstown Landfill site in Co. Kildare (hereafter 'the proposed Project'). The proposed Project includes the remediation and development of an amenity site on the former Kerdiffstown Landfill site.

The planned works within the site boundary include works to re-profile the site including excavation of waste and other materials for deposition on site to achieve the proposed final landform. The works will also include the installation of landfill infrastructure such as capping, landfill gas, leachate and surface water management.

The capping material used will increase the rate of pluvial runoff from the site therefore the purpose of the surface water management system is to maintain runoff from the site to greenfield runoff rates with attenuation ponds for storage. The proposed Project is shown on Figure 4.20.

A second stage of remediation will comprise the works required to restore the site to the proposed park end use, including planting and landscaping, installation of sports pitches, changing rooms, car parks and associated services. The proposed Project is shown on Figure 4.20.

In accordance with Section 28 of the Planning and Development Act 2000, Kildare County Council is required to have regard to the Guidelines on the Planning System and Flood Risk Management, 2009. These guidelines outline the requirement for a flood risk assessment to be carried out to assess the flood risk to the proposed Project, the impact that the proposed works will have on flooding in the surrounding areas and to present mitigation measures, if any, that may be required as a result.

2. Flood Risk Assessment Methodology

The FRM guidelines outline the key principles that should be used to assess flood risk to proposed development sites. It is recommended that a staged approach to flood risk assessment should be used:

- **Stage 1: Flood risk identification** – to identify whether there may be any flooding or surface water management issues relating to the proposed development site that may warrant further investigations.
- **Stage 2: Initial flood risk assessment** – to confirm sources of flooding that may affect the proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. This stage involves the review of existing studies, to assess flood risk and to assist with the development of FRM measures.
- **Stage 3: Detailed flood risk assessment** – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impacts on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model across a wide enough area to appreciate the catchment wide impacts and hydrological process involved.

This report represents a **Flood Risk Identification (Stage 1 Assessment)** and **Initial Flood Risk Assessment (Stage 2 Assessment)** and provides an overview of the potential flood risks to the proposed site and assesses the potential impact of the proposed Project. In addition it proposes mitigation principles that should be pursued as the design is progressed. A Stage 3 Assessment is not proposed as the results from the Stage 1 and 2 Assessments, as outlined in this report, indicate a Stage 3 Assessment is not required.

3. Flood Risk Identification (Stage 1)

3.1 Flood History of the Site

As part of the Stage 1 Assessment (Flood Risk Identification), all readily available data was reviewed (as per the list referenced in Table 4 – Appendix A) to identify whether there may be any flooding or surface water management issues relating to the site that may warrant further investigations.

The aim of this section is to outline the flood history of this site. The main historical flood events in the area were identified, assessed and are described below.

3.1.1 Local Watercourses

Prior to describing historical flood risk below this section describes the watercourses adjacent to the site, illustrated in Diagram 1.1. The closest surface water body to the site is the Morell River (WBR005) which lies to the east of the proposed Project. The Morell River flows generally northwards within 50m of the site boundary before flowing into the River Liffey. The River Liffey itself lies approximately 3km north-west of the site at its closest point, also flowing generally northwards, before following a more eastward flow direction some 5 to 6km north of the landfill site.

The Rathmore Stream (WBR006) lies to the south east of the proposed Project and joins the Morell River upstream east of the proposed Project.

The Canal Feeder Stream (WBR004) is an engineered feature that collects surface water run-off from lands generally to the south and south-west of the site. The Canal Feeder Stream flows generally westward to the Grand Canal, which is located approximately 2km west of the site.

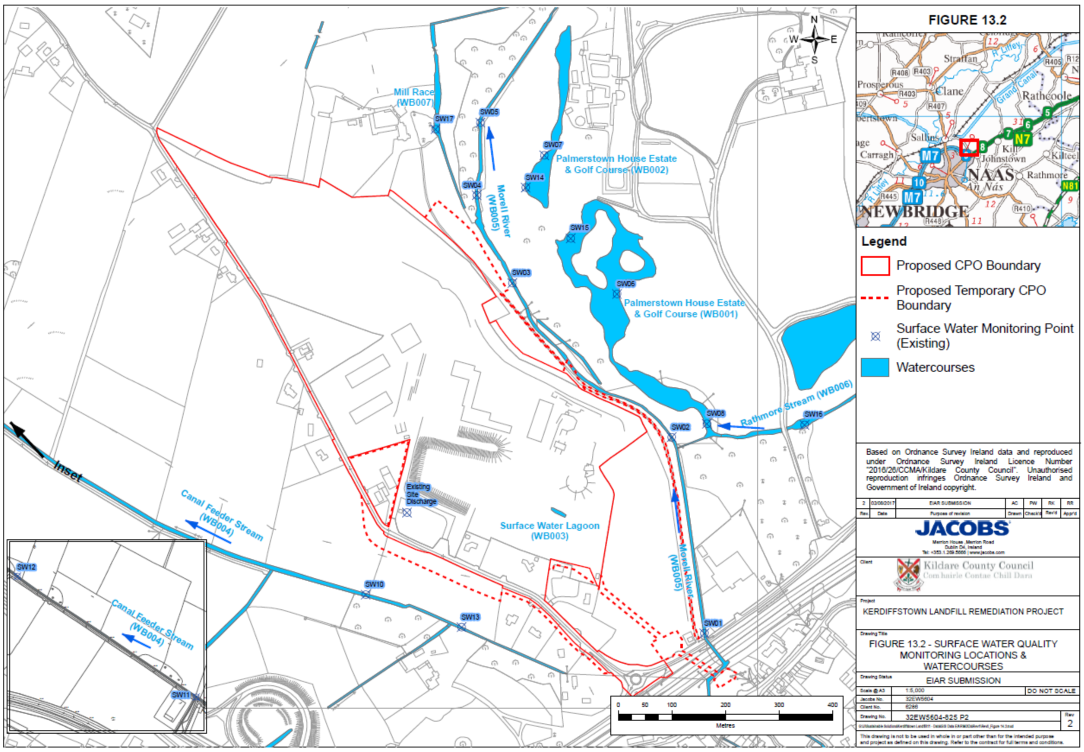


Diagram 1.1:Local Watercourses and Site locations

3.1.2 OPW National Flood Hazard Mapping

With reference to the OPW Flood Hazard Mapping website (www.floodmaps.ie) which is the national portal for retaining flood information, a number of historical flood events were identified within the areas around the proposed Project, namely the Kill, Johnstown and Sallins areas. A Summary Local Area Report detailing this information was downloaded and is included in Appendix B. The key flood event information from this report is outlined in Table 1.

Ref. No.	Date of Flood Event	Address	Description of Event / Comments	Approximate Distance from Project Site
1	30 November 2009	Monread, Sallins, Co. Kildare	Flooding of the Sallins area, particularly the Waterways Estate in Sallins, Co. Kildare	
2	05 November 2000	River Morell, Johnstown, Co.Kildare	Flooding in Johnstown area of Co Kildare due to constrictions caused by under-capacity structures as well as some under-capacity channels.	
3	05 November 2000	Kill River, N7 Road, Co.Kildare	Flooding in Kill area of Co Kildare due to constrictions caused by under-capacity structures.	
4	10 June 1993	Kill River, N7 Road, Co.Kildare	Flooding in Kill area of Co Kildare due to constrictions caused by under-capacity structures.	
5	10 June 1993	River Morell, Johnstown, Co.Kildare	Flooding in Johnstown area of Co Kildare due to constrictions caused by under-capacity structures as well as some under-capacity channels.	
6	26 November 2012	Killeenmore, Co. Kildare	This flooding event occurred close to the location where the Dublin/Cork railway line crosses the Morrell River. The Morrell River broke its banks upstream of the railway line in this location (just downstream of the Canal). The river then flowed across the land and made its way across/through the railway line by flowing through the river culvert and two other local culverts. The water, which flowed through the local culverts, caused the flooding. Flooding frequently occurs in this area.	
7	Recurring	River Morell, Johnstown, Co.Kildare	Flooding in Johnstown area of Co Kildare due to constrictions caused by under-capacity structures as well as some under-capacity channels.	

Table 1: Flood events recorded within the area from the OPW Flood Hazard Mapping Report

A number of reports are also available on the OPW Flood Hazard Mapping website. A selection of these reports are listed below:

- Kildare County Council, National Roads Design Office, N7 Naas Road Widening & Interchanges Scheme, Kill & Johnstown Flood Alleviation Measures Report, June 2002.
- Kildare County Council, National Roads Design Office, N7 Naas Road Widening Interchange Scheme, Hydraulic Model & Flood Alleviation Measures Report, January 2002.
- Kildare County Council Memo, Report Re: Flooding In County Kildare, 5 – 7 November 2000
- OPW Flood Event Report, Flooding at Killeenmore, Co. Kildare, 26th November 2012.

Although these reports identify and describe flood events in the areas surrounding the site, flooding within the site boundary is not mentioned.

3.1.3 Eastern CFRAM Study – Flood Risk Review Report

The Eastern River Basin District Flood Risk Review was carried out as part of the Catchment Based Flood Risk Assessment and Management Study (CFRAMS) process to help validate the findings of the OPW draft Preliminary Flood Risk Assessment (PFRA). These Flood Risk Reviews informed which sites were to be taken forward for a more detailed assessment within the CFRAMS Programme.

The Eastern CFRAM Study Flood Risk Review Report indicates that there is evidence of fluvial flooding from the Morell River in the areas around the proposed Project site. As stated in the Flood Risk Review Report;

'Both Kildare County Council and OPW regional engineering staff have identified the full Morell catchment, as an area of significant flood risk. There is a known recurring flood risk from the Morell River and associated tributaries that has flooded properties in the past.'

The Report indicates that there is a history of flooding of the Johnstown area, approximately 0.6km to the south of the proposed Project site, from the Morell River.

The report also indicates that the Sallins area (approximately 3km from the Project site) is also at risk of flooding from the canal feeder stream which is located to the left of the proposed Project site.

The Johnstown, Naas and Sallins Flood Risk Review Maps (Appendix C) indicate that the land directly adjacent to the proposed Project site is at risk of fluvial flooding in the 0.1%, 1% and 10% Annual Exceedance Probability (AEP) flood events, however it does not show the proposed Project site at risk of flooding.

Although this reports identifies and describes flooding in the areas surrounding the site, flooding within the site boundary is not mentioned.

3.1.4 Flood Risk Maps

The Eastern CFRAM Study Flood Extent and Depth Maps are available online (http://maps.opw.ie/fhrm_pdf_final//east/uom09/naas/01_ex/fluvial/e09naa_exfcd_f0_20.pdf) and the relevant map tile is included in Appendix D. The CFRAM maps are the most up to date flood maps indicating the fluvial & coastal flood risk to an area. Due to the location of the proposed Project site, coastal flooding is not a risk in this area. The CFRAM fluvial extent map of the area indicates that the some of the land directly outside the site perimeter is at risk of fluvial flooding in the 0.1%, 1% and 10% fluvial AEP flood events.

Although this map identifies fluvial flooding in the area surrounding the site, flooding within the site boundary is not shown.

3.1.5 Local Libraries and Newspaper Reports

There are a number of newspaper articles which detail flooding in areas around the study area such as the Sallins and the Johnstown areas. However there are no newspaper articles which detail flooding of the proposed Project site.

3.2 Summary

While it has been concluded that no flooding has occurred within the site boundary, flooding has previously occurred in the vicinity of the site. Proposed works to the site including re-profiling of the site and provision of a capping layer which will increase the rate of runoff from the site. On this basis, a Stage II Flood Risk Assessment has been carried out to develop an understanding of the impacts these proposed works may have to the flood risk on the site and the surrounding areas.

4. Initial Flood Risk Assessment (Stage 2)

This section assesses the risk of flooding to the site once the works are complete from a range of different sources, which is then used to develop a broad understanding of the risk characteristics to the proposed Project and if any mitigation measures are required.

4.1 Potential Sources of Flooding

There is a potential risk from several sources of flooding, as listed below:

- **Coastal** - flooding from the sea;
- **Fluvial** - flooding from rivers and watercourses;
- **Estuarine** - flooding from a combination of fluvial and coastal;
- **Pluvial** – flooding that is caused by runoff during high rainfall events;
- **Artificial Drainage Systems** – flooding that occurs as a result of surcharging or blocking of drainage networks;
- **Groundwater** – flooding when water normally stored below the ground rises above surface level or into below ground spaces (such as basements).

The following sections assess the potential risk from each of these separate sources of flooding.

4.2 Coastal Flood Risk

Coastal flooding is caused by higher sea levels than normal, resulting in the sea overflowing onto the land. Coastal flooding is influenced by three main factors, which often work in combination. These are:

- **High tide levels** – caused by normal, and predictable, astronomical factors.
- **Storm surges** – where sea levels are artificially raised by areas of low barometric pressure such as depression weather systems.
- **Wave action** – this is dependent on wind speed and direction, as well as local topography and exposure.

Due to the sites proximity and elevation from the sea (ground level is above 80mOD), it is reasonable to conclude that there is no flood risk to the proposed Project or site from coastal sources.

4.3 Fluvial Flood Risk

Existing Situation

As stated in Section 3.2, the Eastern CFRAM flood risk maps indicate that there is no fluvial flood risk to the existing site, however areas directly outside the perimeter of the site are currently at risk of fluvial flooding, from the Morell River, in the 0.1%, 1% and 10% fluvial AEP flood events.

Risk Following Proposed Works

As the proposed works to the site include re-profiling of the existing ground contours, this could potentially change the fluvial flood risk extents. The predicted flood level for the Morell River for the 0.1% AEP event, upstream of the site is 83.02mOD. The final landscaped contours of the proposed Project, as shown in Figure 4.20, indicate that the minimum level along the site boundary adjacent to the Morell River is 84mOD.

It is therefore reasonable to conclude that the proposed ground levels at the boundary of the site, adjacent to the Morell River, will be higher than the predicted 0.1% AEP Water Level shown on the CFRAMS mapping; therefore there will be no fluvial flood risk to the site once the proposed works are complete.

4.4 Estuarine Flood Risk

Estuarine flooding occurs due to a combination of tidal and fluvial flows, rivers and the sea. A combination of a high flow and a high tide will force water back upstream, increasing water levels and leading to a river bursting its banks.

For the reasons outlined in Section 4.2 regarding Coastal Flood Risk, it is reasonable to conclude that there is no estuarine flood risk to the proposed Project or site.

4.5 Pluvial Flood Risk

Pluvial flooding occurs during periods of heavy rainfall, when the rainfall rate is greater than the infiltration capacity. It is usually associated with high intensity rainfall events (typically > 30mm/h) resulting in overland flow and ponding in depressions in the topography.

Existing Situation

No evidence of pluvial flood risk on the site was identified in Section 3.

Risk Following Proposed Works

The proposed capping material will increase the runoff rate from the site and limit the infiltration capacity of the site. A Surface Water Management Plan has been developed for the proposed Project. This plan describes a proposed drainage system for the site which limits outflow from the site to $Q_{BAR,}$ which has been calculated as 56.58l/s, in order to ensure that the surface water run-off from the site does not have a detrimental impact on the downstream river network and increase the risk of flooding. The drainage system also comprises a series of ponds which provide attenuation for additional flows during a 1% AEP event, with a 10% climate change factor applied. Further details are included in the Surface Water Management Plan (Document number 32EW5604/DOC/0042 | 0) but given that a design is proposed that will limit the discharge to 56.58l/s, which is equivalent to the greenfield run off rate of Q_{BAR}, it is reasonable to conclude that there will be no pluvial flood risk to the Project or site once the works are complete.

4.6 Artificial Drainage Systems

Existing Situation

Section 1.1.1 of the Environmental Impact Statement (EIS) Volume 2 of 4: Main Report outlines the Current Site Conditions and Drainage System on site. There are no known flooding issues in the existing Artificial Drainage System.

Risk Following Proposed Works

As detailed in Section 4.5, there will be an appropriately designed drainage network to address pluvial runoff on the site. It can therefore be concluded that there will be no flood risk to the Project or site from Artificial Drainage Systems once the works are complete.

4.7 Groundwater Flood Risk

Existing Situation

Groundwater flooding during times when the catchment is saturated and the ground water levels are elevated above the level of the site is unlikely as the site is elevated relative to the surrounding topography. Further to this groundwater monitoring boreholes were in place from 2010-2016 as outlined in Chapter 13 of the EIS Volume 2 of 4: Main Report. During this time, groundwater levels only marginally increased above 83mOD. The ground levels on the site are currently higher than the monitored groundwater levels, therefore the risk of flooding from groundwater is considered low.

Risk Following Proposed Works

The proposed Project involves reprofiling of the site. The lowest levels on the site will be located at the bottom of the attenuation ponds. The ponds are designed to be above groundwater levels. As there are no proposed works below existing groundwater level, it is reasonable to conclude that the risk of flooding from groundwater sources to the Project or site is not increased.

4.8 Flood Risk due to Climate Change

In the future, it is predicted that climate change will increase sea levels, storm events magnitude and frequency, and rainfall depths, intensities and patterns. It is therefore necessary to consider the impact this might have on the flood risk to the proposed Project.

For fluvial flow the standard allowance for climate change for the 1% AEP event is a 20% increase in flow.

The final landscaped contours along the boundary of the proposed Project site will be higher than the predicted water level for the 0.1% AEP fluvial event (which is higher than the 1% AEP plus Climate Change event). Therefore the risk of fluvial flooding to the site as a result of climate change once the proposed works are complete is considered low.

For pluvial flooding, as detailed in Section 4.5, the proposed drainage network design has included a 10% climate change factor. Therefore the risk of pluvial flooding to the site as a result of climate change once the proposed works are complete is considered low.

4.9 Summary of Flood Risk

Table 2 below provides a summary of the potential impact from each of the sources of flooding considered, to the road once the works are complete.

Flood Risk	Summary of Impact	Notes
Coastal	N/A	N/A
Fluvial	Low	The final landscaped contours along the boundary of the proposed Project will be higher than the 0.1% AEP Predicted Water Level.
Estuarine	N/A	N/A
Pluvial	Low	A Surface Water Management Plan has been developed for the proposed Project which includes an adequately designed drainage network for the site.
Artificial Drainage Systems	Low	A Surface Water Management Plan has been developed for the proposed Project which includes an adequately designed drainage network for the site.
Groundwater	Low	No works are proposed below groundwater level.
Climate Change	Low	The final landscaped contours along the boundary of the proposed Project will be higher than the predicted water level of the 0.1% AEP fluvial event (which is higher than the 1% AEP plus Climate Change event).

Table 2: Summary of Flood Risk to Proposed Project

5. Potential Flood Risk Impacts to Surrounding Areas from the Proposed Project

Section 4 considered the flood risk to the Project site once the works were completed. This section, Section 5 considers the potential increased flood risk to the surrounding areas as a result of the works.

The proposed Project could result in an increase in flood risk if it:

- Reduces the conveyance of an existing watercourse and floodplain network;
- Reduces the volume of flood storage available on the watercourse floodplains; or
- Increases site runoff rates and volume.

5.1 Fluvial Flood Risk

As described in Section 4.5 the surface water design for the proposed Project will be a controlled outfall from the site with a discharge rate of 56.58l/s (Q_{BAR}). The outfall will discharge from an on-site attenuation pond to the Morell River. For flood events greater than a Q_{BAR} event the proposed drainage system will reduce the runoff from the site to the River Morell. For flood events below Q_{BAR} the outfall from the site is negligible considering the size of the site is 0.25km^2 compared to overall catchment of 45km^2.

Therefore the proposed Project has no impact on the fluvial flood risk to surrounding areas as a result of the works.

5.2 Pluvial Flood Risk

As described in Section 5.1, a Surface Water Management Plan has been developed for the proposed Project which includes an adequately designed drainage network for the site. The site is landscaped to allow all runoff from the site to flow into the attenuation ponds, therefore flood risk from pluvial sources to the surrounding area will not be increased.

5.3 Artificial Drainage Systems

As described in Section 5.1, a Surface Water Management Plan has been developed for the proposed Project which includes an adequately designed drainage network for the site, therefore flood risk from Artificial Drainage Systems on site to the surrounding area will not be increased.

5.4 Groundwater Flood Risk

The proposed Project involves re-profiling of the site but does not include significant earthworks below groundwater levels that would increase the risk of flooding to the surrounding area from groundwater sources.

5.5 Summary of Flood Risk

Table 3 below provides a summary of the potential flood risk impacts on surrounding areas as a result of the proposed Project.

Flood Risk	Summary of Impact	Notes
Coastal	N/A	
Fluvial	Negligible Impact	Any increase in Flood risk from fluvial sources to the surrounding area is considered negligible.
Estuarial	N/A	
Pluvial	No Impact	Flood risk from pluvial sources to the surrounding area will not be increased.
Artificial Drainage Systems	No Impact	Flood risk from artificial drainage systems to the surrounding area will not be increased.
Groundwater	No Impact	Flood risk from groundwater sources to the surrounding area will not be increased.
Climate Change	N/A	The impact from the proposed Project on Climate Change is considered non-applicable.

Table 3: Summary of the potential flood risk impacts on surrounding areas as a result of the proposed Project.

6. Conclusions and Recommendations

6.1 Conclusions

This report provides an assessment of the flood risk issues that could affect the proposed Project and the surrounding area. The assessment has included desktop investigations into the potential flood risks and an assessment of the potential impacts the development could have on flood risk in the surrounding areas.

In the design of the project the following mitigation measures have been applied;

- The proposed finished ground levels along the Morell River are above the predicted flood levels.
- As the proposed works reduce onsite infiltration of runoff, surface water management systems have been included as part of the design to limit runoff from the site to greenfield rates.

Further to these mitigation measures all residual flood risks and impacts have been assessed as having a ‘low’ categorisation as the potential increase in flow discharging from the Project is being controlled by the planned surface water management system.

As per ‘The Planning System and Flood Risk Management, Guidelines for Planning Authorities’ (2009), a Justification Test was not deemed necessary for the works as there is no existing flood risk to the site and the site is not located in a Flood Zone.

6.2 Recommendations

It has been concluded that flood risks and impacts associated with the proposed Project are low or negligible, therefore further detailed modelling, i.e. Stage 3 Detailed Risk Assessment is not required.

On securing lands necessary to facilitate the remediation of the site, detailed design will be undertaken for the final surface water management system. This design will reaffirm the landscaping and ensure that levels are maintained above the predicted flood risk levels and meets the requirements of the EIS and the Surface Water Management Plan. These levels will need to be subsequently verified during the construction phase of the works.

Appendix A. Information Sources Checklist

No.	Information Source	Status	Reference/Comments
1	OPW Preliminary Flood Risk Assessment indicative fluvial flood maps	√	Eastern CFRAMS Preliminary Flood Risk Assessment Maps
2	National Coastal Protection Strategy Study flood and coastal erosion risk maps.	N/A	
3	Predictive and historic flood maps, and Benefiting Lands Map	√	
4	Predictive flood maps produced under the CFRAM studies	√	
5	River Basin Management Plans and reports	√	Kildare County Development Plan 2011 – 2017, Maps
6	Indicative assessment of existing flood risk under Preliminary Flood Risk Assessment	√	Eastern CFRAMS Flood Risk Review Report and Maps – Appendix C
7	Previous Strategic Flood Risk Assessments	√	1) Strategic Flood Risk Assessment for Kildare County Development Plan 2011-2017 2) Draft Strategic Flood Risk Assessment for Kildare Draft County Development Plan 2017-2023
8	Expert advice from OPW who may be able to provide reports containing the results of detailed modelling and flood-mapping studies including critical damage areas, and information on historic flood events and local studies etc.	N/A	
9	Topographical maps, in particular digital elevation models produced by aerial survey or ground survey techniques.	√	
10	Information on flood defence condition and performance	N/A	
11	Alluvial deposit maps	N/A	
12	'Liable to Flood' markings on the old 6" Inch Map	√	Historic OSI 6" Map

13	Local Libraries and newspaper reports	√	Adequate information on Flooding History was provided by OPW floodmaps.ie.
14	Interviews with local people, local history/ natural history societies etc;	X	
15	Walkover survey to asses potential sources of flooding, likely routes for flood water and the site's key features, including flood defences, and their condition	X	
16	National , regional and local spatial plans, such as the National Spatial Strategy, regional planning guidelines, development plans and local area plans provide key information on existing and potential future receptors	√	The following Plans were referred to: 1) Kildare County Development Plan 2011-2017 2) Strategic Flood Risk Assessment for Kildare County Development Plan 2011-2017 3) Kildare Draft County Development Plan 2017-2023 4) Draft Strategic Flood Risk Assessment for Kildare Draft County Development Plan 2017-2023

Table 4: Information Checklist Table

Appendix B. OPW Summary Local Area Report

OPW *National Flood Hazard Mapping*

Summary Local Area Report

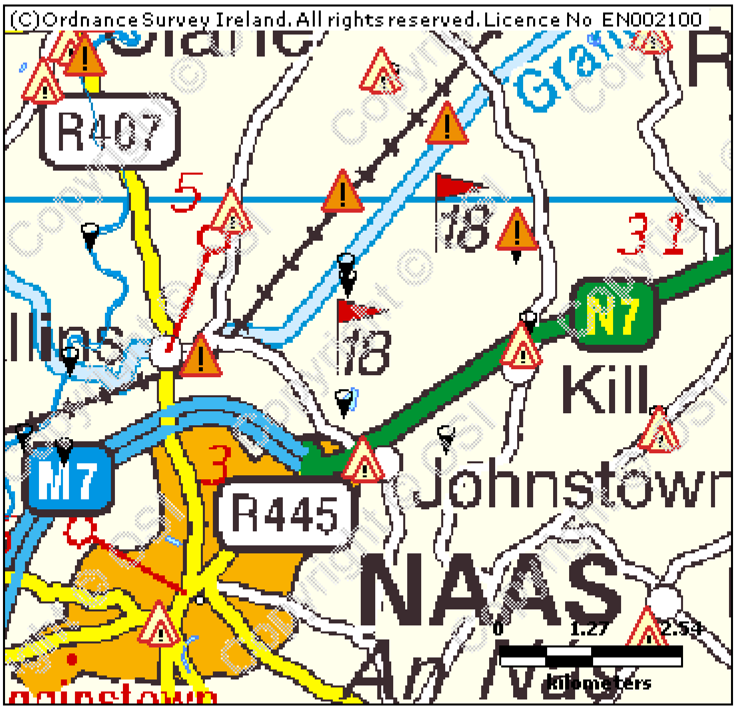
This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Kildare

NGR: N 919 229

This Flood Report has been downloaded from the Web site www.floodmaps.ie. The users should take account of the restrictions and limitations relating to the content and use of this Web site that are explained in the Disclaimer box when entering the site. It is a condition of use of the Web site that you accept the User Declaration and the Disclaimer.



Map Scale 1:105,097

Map Legend
Flood Points
Multiple / Recurring Flood Points
Areas Flooded
Hydrometric Stations
Rivers
Lakes
River Catchment Areas
Land Commission *
Drainage Districts *
Benefiting Lands *

* Important: These maps do not indicate flood hazard or flood extent. Thier purpose and scope is explained in the Glossary.

7 Results

1. Monread Sallins Co Kildare 30th Nov 2009 — Start Date: 29/Nov/2009
County: Kildare — Flood Quality Code:3
Additional Information: Reports (2) More Mapped Information

2. Morell Johnstown Nov 2000 — Start Date: 05/Nov/2000
County: Kildare — Flood Quality Code:2
Additional Information: Reports (2) More Mapped Information

3. Kill River N7 road Nov 2000 — Start Date: 05/Nov/2000
County: Kildare — Flood Quality Code:3
Additional Information: Reports (2) More Mapped Information

4. Kill River N7 road June 1993 — Start Date: 10/Jun/1993
County: Kildare — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

5. Morell Johnstown June 1993 — Start Date: 10/Jun/1993
County: Kildare — Flood Quality Code:3

Additional Information: Reports (2) More Mapped Information

6. Flooding at Killeenmore, Co. Kildare 26th November 2013

Start Date: 26/Nov/2012

County: Kildare

Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

7. Morell Johnstown Recurring

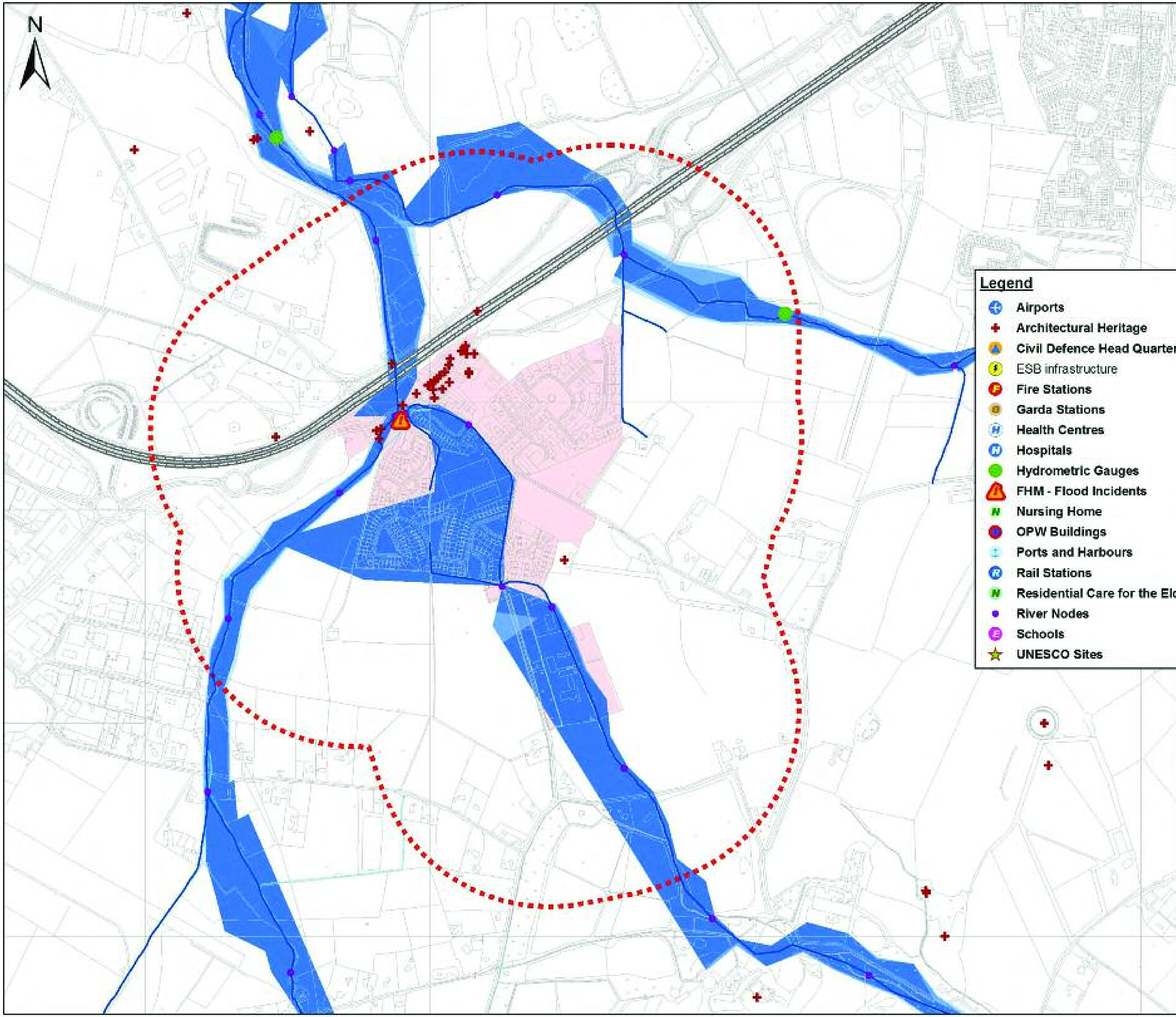
Start Date:

County: Kildare

Flood Quality Code:3

Additional Information: Reports (2) More Mapped Information

Appendix C. Eastern CFRAM Study – Flood Risk Review Maps



Legend

- Airports
- Architectural Heritage
- Civil Defence Head Quarters
- ESB infrastructure
- Fire Stations
- Garda Stations
- Health Centres
- Hospitals
- Hydrometric Gauges
- FHM - Flood Incidents
- Nursing Home
- OPW Buildings
- Ports and Harbours
- Rail Stations
- Residential Care for the Elderly
- River Nodes
- Schools
- UNESCO Sites
- Waste Water Treatment Works
- Water Treatment Works
- Additional watercourses
- OPW Embankments
- Rail Network
- River Centreline
- Roads (National Road Authority)
- 0.1% AEP Flood Extent
- 1% AEP Flood Extent
- 10% AEP Flood Extent
- Airport Land
- Benefiting Lands
- National Heritage Area
- Proposed National Heritage Area
- Special Area for Conservation
- Special Protection Area
- Development_Limits
- Development Limits 500m Buffer

CLIENT

OPW
The Office of Public Works
Oifig na nOibreacha Poiblí

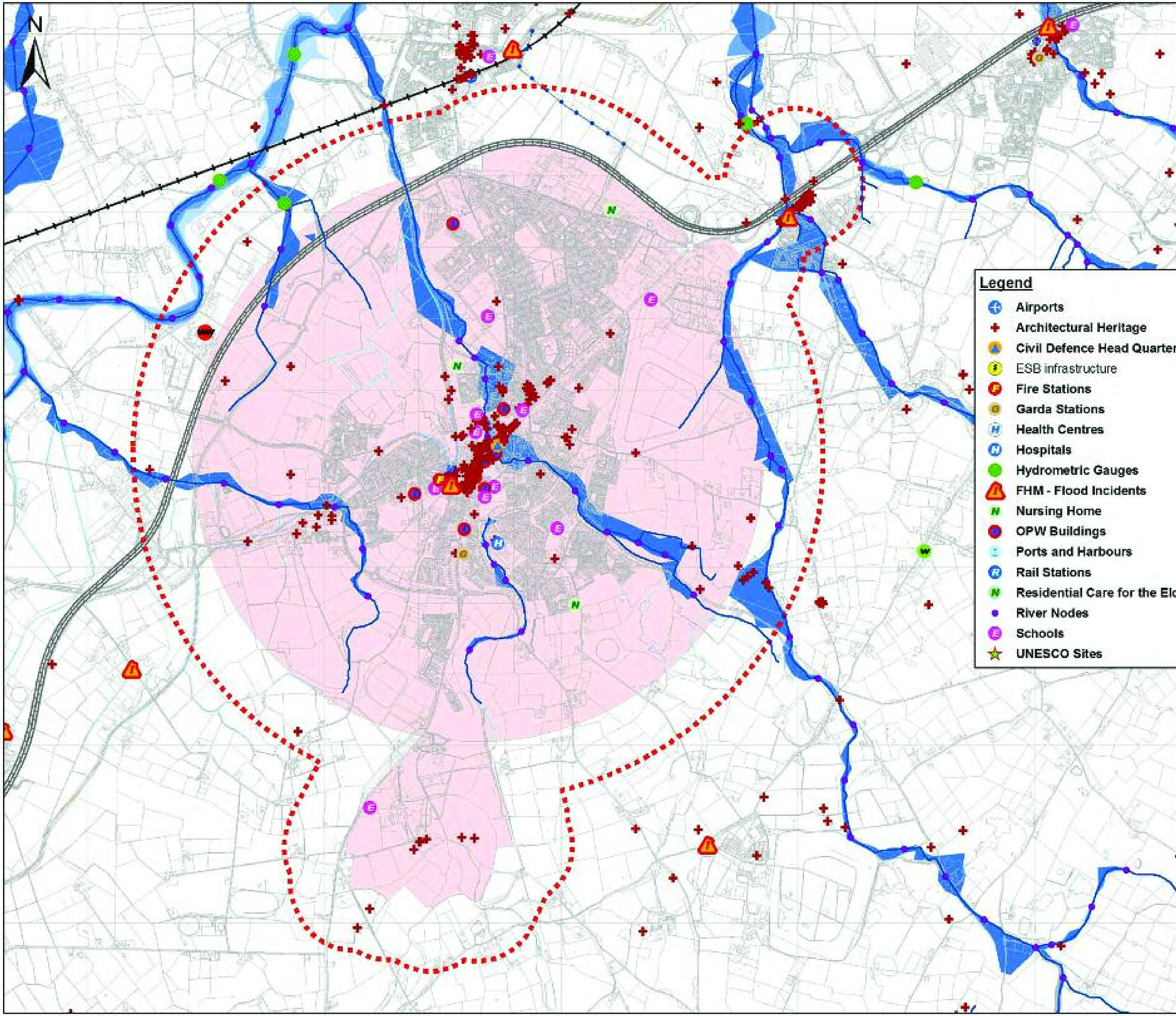
PROJECT
EASTERN CFRAMS

TITLE
Possible AFA - JOHNSTOWN
CO. KILDARE - 8 of 20

RPS Consulting Engineers
ELMWOOD HOUSE
74 BOUCHER ROAD
BELFAST BT12 6RZ
TEL : 028 9066 7914
FAX : 028 9066 8286
www.rpsgroup.com/ireland

Drawing No. : IBE0600_FRR_0508

Drawn By : R.C.
Checked By : M.W
Approved By : M.B
Date : 07/06/11
SCALE : 1:10,000



Legend

- Airports
- Architectural Heritage
- Civil Defence Head Quarters
- ESB infrastructure
- Fire Stations
- Garda Stations
- Health Centres
- Hospitals
- Hydrometric Gauges
- FHM - Flood Incidents
- Nursing Home
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- Ports and Harbours
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- Waste Water Treatment Works
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- 1% AEP Flood Extent
- 10% AEP Flood Extent
- Airport Land
- Benefiting Lands
- National Heritage Area
- Proposed National Heritage Area
- Special Area for Conservation
- Special Protection Area
- Development_Limits
- Development Limits 500m Buffer

CLIENT

OPW
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Oifig na nOibreacha Poiblí

PROJECT

EASTERN CFRAMS

TITLE

Probable AFA - NAAS
CO. KILDARE - 15 of 20

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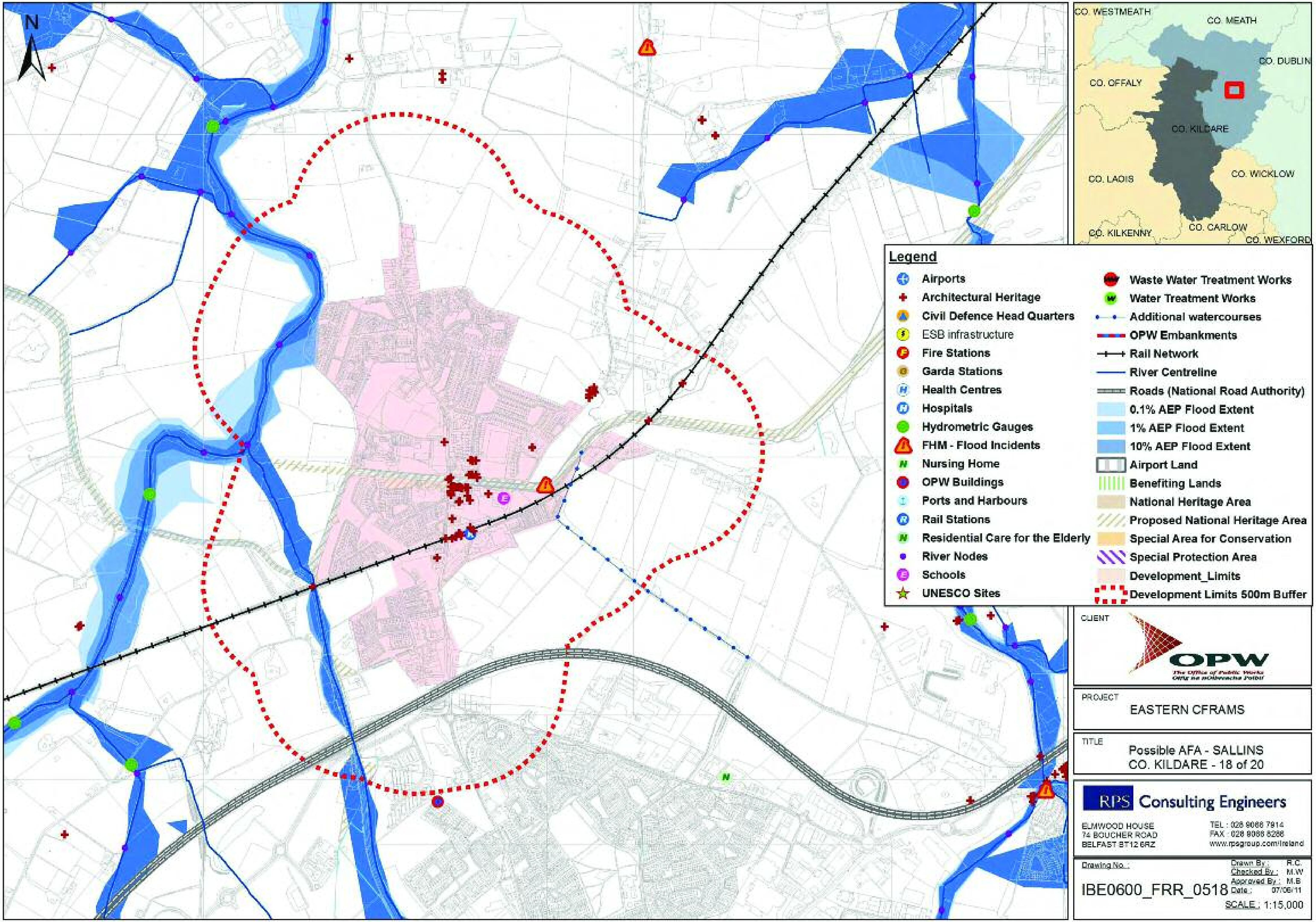
Drawing No.: IBE0600_FRR_0515

Drawn By : S.N.
Checked By : M.W
Approved By : M.B
Date : 13/06/11
SCALE : 1:30,000


N
CO. WESTMEATH
CO. MEATH
CO. DUBLIN
CO. OFFALY
CO. KILDARE
CO. LAOIS
CO. WICKLOW
CO. KILKENNY
CO. CARLOW
CO. WEXFORD
Legend
Airports
Architectural Heritage
Civil Defence Head Quarters
ESB infrastructure
Fire Stations
Garda Stations
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Hospitals
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0.1% AEP Flood Extent
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Development Limits 500m Buffer
CLIENT
OPW
The Office of Public Works
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PROJECT
EASTERN CFRAMS
TITLE
Possible AFA - SALLINS
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IBE0600_FRR_0518
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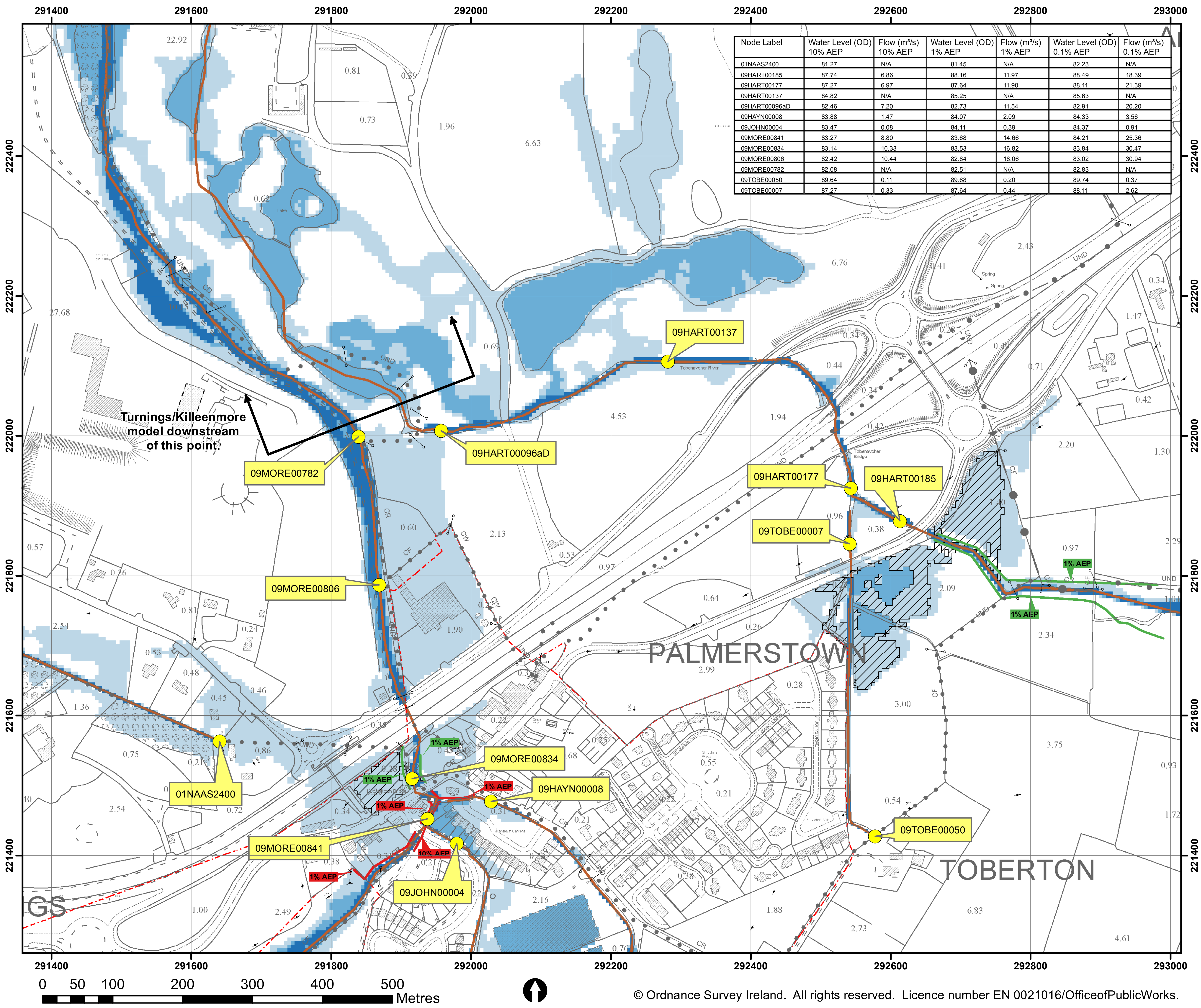
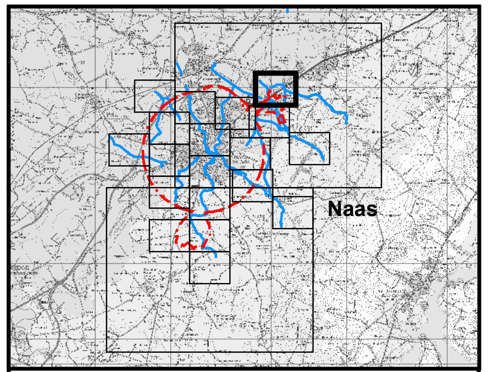
Approved By : M.B
Date : 07/06/11
SCALE : 1:15,000

Appendix D. OPW Eastern CFRAMS Fluvial Flood Map



Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
01NAAS2400	81.27	N/A	81.45	N/A	82.23	N/A
09HART00185	87.74	6.86	88.16	11.97	88.49	18.39
09HART00177	87.27	6.97	87.64	11.90	88.11	21.39
09HART00137	84.82	N/A	85.25	N/A	85.63	N/A
09HART00096aD	82.46	7.20	82.73	11.54	82.91	20.20
09HAYN00008	83.88	1.47	84.07	2.09	84.33	3.56
09JOHN00004	83.47	0.08	84.11	0.39	84.37	0.91
09MORE00841	83.27	8.80	83.68	14.66	84.21	25.36
09MORE00834	83.14	10.33	83.53	16.82	83.84	30.47
09MORE00806	82.42	10.44	82.84	18.06	83.02	30.94
09MORE00782	82.08	N/A	82.51	N/A	82.83	N/A
09TOBE00050	89.64	0.11	89.68	0.20	89.74	0.37
09TOBE00007	87.27	0.33	87.64	0.44	88.11	2.62



IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

Legend

- 10% Fluvial AEP Event
- 1% Fluvial AEP Event
- 0.1% Fluvial AEP Event
- Modelled River Centreline
- AFA Extents
- Embankment
- Wall
- Defended Area
- 1% AEP / 1% AEP — Standard of Protection of Flood Defence (Walls / Embankments)
- Node Point
- Node ID — Node Label

FINAL

REV:	NOTE:	DATE:
01	Amendments made to wire grid.	20/09/16

EASTERN CFRAM STUDY

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W www.rpsgroup.com
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Map:
Naas Fluvial Flood Extents

Map Type: EXTENT
Source: FLUVIAL
Map Area: HPW
Scenario: CURRENT

Drawn By : C.C.	Date : 20 September 2016
Checked By : T.D.	Date : 20 September 2016
Approved By : G.G.	Date : 20 September 2016

Drawing No. :
E09NAA_EXFCD_F1_20

Map Series : Page 20 of 21

Drawing Scale : 1:5,000 @ A3

Appendix A13.2 Monitoring Details

1. Sampling Suites - Surface

Table 1: Comprehensive Suite (Six Monthly Sampling)

Metals and Metalloids
Aluminium
Arsenic
Boron
Barium
Beryllium
Calcium
Cadmium
Lead
Chromium
Copper
Iron
Mercury
Potassium
Magnesium
Manganese
Sodium
Antimony
Selenium
Vanadium
Zinc
Nickel
Indicator Parameters
BOD
COD
Electrical conductivity
Ammoniacal nitrogen (as N)
Total alkalinity
Total organic carbon (TOC)

Anions
Phosphates
Chloride
Nitrite
Nitrate
Sulphate
Sulphide
Free cyanide
Total cyanide
Petroleum Hydrocarbons
TPH (CWG)Polycyclic aromatic hydrocarbons
Polycyclic aromatic hydrocarbons (PAHs)
PAH (USEPA 16)
Volatile organic compounds (VOCs)
VOCs
Semi VOCs
Other Organics
Phenols (low level)
Formaldehyde
Pesticides
OCP and OPP pesticides (to include mecoprop)
Field Measurements
Dissolved oxygen
pH
Electrical Conductivity
Redox (Eh)
Temperature

Table 2: Key Parameter Suite (Monthly Sampling)

Metals and Metalloids
Potassium
Arsenic
Iron
Calcium
Manganese
Sodium
Indicator Parameters
BOD
COD
pH
TOC
Total alkalinity

Anions
Chloride
Nitrate
Sulphate
Total cyanide
Field Measurements
Dissolved oxygen
pH
Electrical Conductivity
Redox (Eh)
Temperature

In Situ sampling provided results for the following suite of parameters:

- Temperature;
- pH;
- Electrical Conductivity (EC);
- Dissolved Oxygen (DO); and
- Redox potential (Eh).

2. Surface Water Monitoring Results

Table 3: Six Monthly Surface Water Monitoring Sites

Analyte	Freq	Units	Fresh Water EQS (AA)	SW01 (Morell River upstream)						SW02					
Sampling Date				**Oct-13**	**Jul-14**	**Dec-14**	**Aug-15**	**Dec-15**	**Jun-16**	**Oct-13**	**Jul-14**	**Dec-14**	**Aug-15**	**Dec-15**	**Jun-16**
Calcium , Total as Ca	M	mg/l	-	123	96	112	100	123	98.5	94	90	107	97.7	116	98.9
Magnesium, Total as Mg	B	mg/l	-	12.3	11.7	11.2	12.6	10.6	11.8	9.2	11.3	9.4	12.2	8.5	10.8
Potassium , Total as K	M	mg/l	-	1.6	1.0	1.1	1.15	1.33	0.71	3.2	1.1	1.2	1.24	1.47	1.22
Sodium , Total as Na	M	mg/l	-	9.5	7.9	7.8	8.9	8.1	7.55	11.1	8.8	7.8	9.72	8.28	8.69
Alkalinity as CaCO3	M	mg/l	-	289	265	287	248	315	277	234	263	273	240	292	256
Sulphate as SO4	M	mg/l	-	18.9	14.7	16.4	15.2	18.4	15.7	25.6	17.0	16.0	17.1	49.3	17.6
Chloride as Cl	M	mg/l	-	18.7	17.0	16.2	19.5	17.2	19	20.4	18.5	16.2	19.4	16.2	17.7
Nitrate as NO3*	M	mg/l	-	13.4	11.8	11.0	13.8	10.5	12.5	9.8	13.1	10.2	12.7	9.9	14
Ammoniacal Nitrogen as $N^{\#}$	M	mg/l	-	<0.27	<0.06	<0.06	<0.06	<0.28	<0.06	<0.27	<0.06	<0.06	<0.06	<0.06	<0.06
Nitrite as NO2*	B	mg/l	-	<0.83	<0.083	<0.083	<0.083	<0.28	<0.28	<0.083	<0.083	<0.083	<0.083	<0.28	<0.28
Phosphates , Total as PO4*	B	mg/l	-	<0.120	<0.37	<0.37	<0.37	<0.120	<0.120	<0.120	<0.37	<0.37	<0.37	<0.120	<0.120
Boron, Total as B	B	mg/l	-	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23
Fluoride as F	B	mg/l	-	<0.2	<0.2	<0.2	0.1	0.1	0.1	<0.2	<0.2	<0.2	0.1	<0.1	0.1
Iron , Total as Fe	M	mg/l	-	1.1	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23
Manganese , Total as Mn	M	mg/l	-	0.22	0.03	0.03	0.008	0.04	<0.007	0.06	0.02	0.03	0.012	0.036	0.032
Arsenic, Total as As	M	µg/l	25	<1.4	<1.4	<1.0	<1	<1	<1	1.4	<1.4	<1.0	<1	<1	<1
Barium, Total as Ba	B	µg/l	-	88	69	77	73	79	68	69	68	70	72	68	65
Beryllium, Total as Be	B	µg/l	-	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
Cadmium , Total as Cd	B	µg/l	0.2	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chromium , Total as Cr	B	µg/l	5	<2.0	<2.0	<2.0	<2	<2	<2	<2.0	<2.0	<2.0	<2	<2	<2
Copper, Total as Cu	B	µg/l	5	<9.0	<9.0	<9.0	<1.9	2.2	<1.9	<9.0	<9.0	<9.0	<1.9	<1.9	<1.9
Lead , Total as Pb	B	µg/l	7.2	<6.0	<6.0	<6.0	<6	<6	<6	<6.0	<6.0	<6.0	<6	<6	<6
Nickel , Total as Ni	B	µg/l	20	3	<3.0	<3.0	<3	7	<3	3	<3.0	<3.0	<3	<3	8
Selenium, Total as Se	B	µg/l	-	<1.6	<1.6	2	<0.8	3.3	1.5	5	<1.6	2	0.8	2.7	1.1
Vanadium , Total as V	B	µg/l	-	<4.0	<4.0	<4.0	<4	<4	<4	<4.0	<4.0	<4.0	<4	<4	<4
Zinc, Total as Zn	B	µg/l	50	30	<18.0	<18.0	<18	<18	<18	<18	<18.0	<18.0	<18	<18	<18
Cyanide, Total	M	µg/l	-		14	<9.0	<9	<9	<9		<9.0	<9.0	<9	<9	<9
Conductivity- Electrical 20C	M	uS/cm							515						547
TOC (Filtered)	M	mg/l		1.5	1.7	1.3	<0.7	2.5	1.1	3.9	1.5	1.4	0.8	2.6	12.9
BOD + ATU (5 day)	M	mg/l			1	<1	<1	2	2	1.8	<1	<1	<1	1	1
COD (Total)	M	mg/l		<10	<10	<10	<10	7	<11	14	<10	<10	<10	<5	15
pH	M	pH units		8.36	8.1		8.12	8.13	8.14	7.88	8.18		8.13	8.38	8.19

JACOBS

Analyte	Freq	Units	Fresh Water EQS (AA)	SW03						SW05						Site Discharge					
Sampling Date				Oct-13	Jul-14	Dec-14	Aug-15	Dec-15	Jun-16	Oct-13	Jul-14	Dec-14	Aug-15	Dec-15	Jun-16	Oct-13	Jul-14	Dec-14	Aug-15	Dec-15	Jun-16
Calcium , Total as Ca	M	mg/l	-	93	89	115	98.3	116	101	101	95	111	88.1	115	99.6	29	29		20.2	25.1	17.8
Magnesium, Total as Mg	B	mg/l	-	8.8	10.9	10.0	12.3	8.5	11.1	9.4	11.5	9.6	11.2	8.4	10.8	1.4	1.8		<0.6	1.2	<0.6
Potassium , Total as K	M	mg/l	-	3.2	1.1	1.5	1.24	1.47	0.83	2.9	1.2	1.2	0.98	1.47	0.79	1.2	0.7		1.59	1.57	1.15
Sodium , Total as Na	M	mg/l	-	11.5	8.6	8.8	9.76	8.16	8.13	10.2	9.2	8.0	8.8	8.18	7.8	2.4	2.4		1.4	1.38	1.1
Alkalinity as CaCO3	M	mg/l	-	228	274	274	240	292	247	262	235	271	241	288	270	371	48		44.7	104	44.4
Sulphate as SO4	M	mg/l	-	27.0	17.4	16.1	16.7	19.5	18.7	26.4	18.2	16.1	16.4	17.1	16.8	14.1	10.1		12.6	20.1	5.3
Chloride as Cl	M	mg/l	-	20.1	18.2	15.8	20	16.2	18.5	21.0	17.9	16.8	17.7	17.8	18.8	6.3	7.0		4.23	<3.7	<3.7
Nitrate as NO3*	M	mg/l	-	9.2	11.9	10.0	12.3	9.9	10.8	9.3	11.0	13.4	12	9.8	11	<1.9	<1.9		<3.1	<3.1	<3.1
Ammoniacal Nitrogen as N#	M	mg/l	-	<0.27	<0.06	<0.06	<0.06	<0.06	<0.06	<0.27	<0.06	<0.06	<0.06	<0.06	<0.06	<0.27	<0.06		0.12	<0.06	0.15
Nitrite as NO2*	B	mg/l	-	<0..083	<0.083	<0.083	<0.083	<0.28	<0.28	<0.083	<0.083	<0.083	<0.083	<0.28	<0.28	<0.025	<0.083		<0.025	<0.28	<0.28
Phosphates , Total as PO4*	B	mg/l	-	<0.120	<0.37	<0.37	<0.37	<0.120	<0.120	<0.120	<0.37	<0.37	<0.37	<0.120	<0.120	<0.120	0.58		<0.37	<0.120	<0.120
Boron, Total as B	B	mg/l	-	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23		1.29	<0.23	<0.23
Fluoride as F	B	mg/l	-	-	<0.2	<0.2	0.1	<0.1	0.1	-	<0.2	<0.2	0.1	<0.1	0.1	<0.2	<0.2		<0.1	<0.1	<0.1
Iron , Total as Fe	M	mg/l	-	0.4	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	0.8	3.4		<0.23	<0.23	<0.23
Manganese , Total as Mn	M	mg/l	-	0.08	0.02	0.03	0.01	0.038	0.01	0.06	0.02	0.03	0.018	0.037	0.011	0.06	0.27		0.012	0.017	0.102
Arsenic, Total as As	M	µg/l	25	1.6	<1.4	<1.0	<1	<1	<1	<1.4	<1.4	<1.0	<1	<1	<1	3.5	9.4		<1	1.5	2.5
Barium, Total as Ba	B	µg/l	-	69	66	74	73	0.069	67	74	70	71	66	68	65	19	48		14	11	13
Beryllium, Total as Be	B	µg/l	-	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1		<2.1	<2.1	<2.1
Cadmium , Total as Cd	B	µg/l	0.2	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	0.6		<0.6	<0.6	<0.6
Chromium , Total as Cr	B	µg/l	5	<2.0	<2.0	<2.0	<2	<2	<2	<2.0	<2.0	<2.0	<2	<2	<2	<2.0	4.0		<2	<2	<2
Copper, Total as Cu	B	µg/l	5	<9.0	<9.0	<9.0	<1.9	<1.9	<1.9	<9.0	<9.0	<9.0	2.3	<1.9	<1.9	18	21		2.9	2.8	3.9
Lead , Total as Pb	B	µg/l	7.2	<6.0	<6.0	<6.0	<6	<6	<6	<6.0	<6.0	<6.0	<6	<6	<6	<6	25		<6	<6	<6
Nickel , Total as Ni	B	µg/l	20	4	<3.0	<3.0	<3	4	<3	5	<3.0	<3.0	4	3	<3	4	9		<3	<3	<3
Selenium, Total as Se	B	µg/l	-	4	<1.6	2	<0.8	2.7	1.5	5	<1.6	1	0.9	3	1.6	<1.6	<1.6		<0.8	<0.8	<0.8
Vanadium , Total as V	B	µg/l	-	<4.0	<4.0	<4.0	<4	<4	<4	5	<4.0	<4.0	<4	<4	<4	4	9		<4	<4	<4
Zinc, Total as Zn	B	µg/l	50	<18	<18.0	<18.0	<18	<18	<18	<18	<18.0	<18.0	<18	<18	<18	90	90		<18	70	20
Cyanide, Total	M	µg/l	-		<9.0	<9.0	<9	<9	<9		<9.0	<9.0	<9	<9	<9		<9.0		<9	<9	<9
Conductivity- Electrical 20C	M	uS/cm							515						520						100
TOC (Filtered)	M	mg/l		3.8	1.5	1.3	<0.7	2.6	1.3	3.9	1.7	1.5	<0.7	2.5	1.4	9	5.8		3.2	1	2.2
BOD + ATU (5 day)	M	mg/l			<1	<1	<1	1	1		<1	<1	<1	3	2		4	N/S	<1	<1	1
COD (Total)	M	mg/l		16	<10	<10	<10	<5	<11.0		<10	<10	<10	<5	<11.0	34	170	N/S	<10	<5	<11.0
pH	M	pH units		7.66	8.18		8.15	8.35	8.16	7.83	8.01		8.14	8.25	8.15				7.98	7.58	7.5

JACOBS

Analyte	Freq	Units	Fresh Water EQS (AA)	SW11						SW13					
Sampling Date				**Oct-13**	**Jul-14**	**Dec-14**	**Aug-15**	**Dec-15**	**Jun-16**	**Oct-13**	**Jul-14**	**Dec-14**	**Aug-15**	**Dec-15**	**Jun-16**
Calcium , Total as Ca	M	mg/l	-	114	117	115	99.7	113	103	150	120	150	103	80	68.2
Magnesium, Total as Mg	B	mg/l	-	7.0	8.8	9.3	8.6	8.4	6.7	8.2	6.3	8.4	5.5	4.3	3.8
Potassium , Total as K	M	mg/l	-	4.8	1.9	2.2	2.23	2.91	2.9	4.1	2.5	3.5	3.6	1.7	1.45
Sodium , Total as Na	M	mg/l	-	91.9	29.8	15.6	16.3	17.7	35.9	43.1	34.6	53.6	40.8	24.5	21.1
Alkalinity as CaCO3	M	mg/l	-	313	299	319	245	255	267	395	340	355	244	167	169
Sulphate as SO4	M	mg/l	-	32.5	22.7	17.5	16.9	20.9	25.7	31.1	27.7	45.6	33.6	37.3	22.9
Chloride as Cl	M	mg/l	-	136.0	48.9	31.0	29.5	32.1	51.6	62.0	53.1	88.3	62.1	38.8	36.7
Nitrate as NO3*	M	mg/l	-	4.7	8.9	11.9	6.9	9.6	4.8	<1.9	<1.9	2.8	<3.1	<3.1	<3.1
Ammoniacal Nitrogen as N[#]	M	mg/l	-	<0.27	<0.06	<0.06	0.07	<0.06	<0.06	5.0	2.9	1.3	3.3	0.7	0.62
Nitrite as NO2*	B	mg/l	-	0.11	0.18	<0.083	<0.28	<0.28	<0.28	<0.083	<0.083	<0.083	<0.025	<0.28	<0.28
Phosphates , Total as PO4*	B	mg/l	-	0.15	<0.37	<0.37	<0.37	0.16	<0.120	0.46	0.67	0.55	2.21	0.19	<0.120
Boron, Total as B	B	mg/l	-	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23	1.74	<0.23	<0.23
Fluoride as F	B	mg/l	-	0.3	<0.2	<0.2	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.5
Iron , Total as Fe	M	mg/l	-	0.4	<0.23	<0.23	<0.23	<0.23	<0.23	1.7	1.2	1.4	1.4	1.2	0.58
Manganese , Total as Mn	M	mg/l	-	0.12	0.02	0.02	0.021	0.009	0.028	0.73	0.43	0.60	0.48	0.26	0.169
Arsenic, Total as As	M	µg/l	25	<1.4	<1.4	<1.0	<1	<1	<1	5.7	6.8	3.8	4.6	5.2	4.1
Barium, Total as Ba	B	µg/l	-	73	74	66	62	59	61	119	89	106	72	53	42
Beryllium, Total as Be	B	µg/l	-	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
Cadmium , Total as Cd	B	µg/l	0.2	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chromium , Total as Cr	B	µg/l	5	<2.0	<2.0	<2.0	<2	<2	<2	<2.0	<2.0	<2.0	<2	4.0	4
Copper, Total as Cu	B	µg/l	5	<9.0	<9.0	<9.0	2.2	2	4.4	<9.0	<9.0	<9.0	<1.9	8	3.9
Lead , Total as Pb	B	µg/l	7.2	<0.6	<6.0	<6.0	<6	<6	<6	<0.6	<6.0	<6.0	<6	<6	<6
Nickel , Total as Ni	B	µg/l	20	10	5	5	3	3	8	<3	<3.0	<3.0	<3	9	16
Selenium, Total as Se	B	µg/l	-	<1.6	4	2	<0.8	1.8	1.7	<1.6	<1.6	2	<0.8	<0.8	<0.8
Vanadium , Total as V	B	µg/l	-	<4	<4.0	7	<4	<4	<4	7	6	9	<4	<4	<4
Zinc, Total as Zn	B	µg/l	50	60	<18.0	<18.0	<18	<18	<18	<18	<18.0	<18.0	<18	50	<18
Cyanide, Total	M	µg/l	-		<9.0	<9.0	<9	<9	<9		<9.0	<9.0	<9	<9	<9
Conductivity- Electrical 20C	M	uS/cm							620						444
TOC (Filtered)	M	mg/l		3.4	3.1	2.6	2.7	4	3	7.8	9.2	6.6	5.9	4.7	3
BOD + ATU (5 day)	M	mg/l			<1	2	1	3	1		2	2	3	2	3
COD (Total)	M	mg/l		<20	<10	35	<10	13	<11.0	27	22	11	20	87	12
pH	M	pH units		8.16			7.79	8.1	7.75	7.64			7.56	7.44	7.19