Completion criteria for MWS landfill aftercare

Olivier Bour, Isabelle Zdanevitch

COMPLETION CRITERIA FOR MSW LANDFILL AFTERCARE

O. BOUR*, I. ZDANEVITCH*

** INERIS, Parc ALATA, 60 550 Verneuil-en-Halatte, France*

SUMMARY: Different aspects of the completion of aftercare period were discussed in a new French workgroup (WG) devoted to give some guidelines for assessing the end of the aftercare and the end of monitoring period for new landfills. The paper presents some of the points discussed in the first meeting and orientations given by the WG. Some parameters need to be considered, especially the water mass balance, in a more refined way, to precise the behaviour of the waste body. A statistical treatment of the data of french landfill leachate discharges gives also some information concerning the distribution of leachate nickel concentrations, which represent a possible tracer for the most mobile heavy metals. The different options proposed for the passive to active treatment of the whole waste body need further discussions in the WG concerning the attenuation parameters and the degradation of the cover.

1. INTRODUCTION

A new french regulation concerning MSW landfill exploitation (15/02/2016) initiates a period of survey with passive collection of leachates and biogas at end of aftercare period (with active collection of biogas and leachates). The goals of this survey period are to observe modifications of environment and behavior of landfills. That period will give information, which are needed to be compared with previous monitoring phase and expected modifications (level of leachates, emissions of biogas). These data will be processed in order to evaluate landfill behavior and try to assess risk for environment and human health.

Emissions of biogas and leachate during aftercare period are generally controlled by active collection and treatment. Decline of biogas production and modifications of composition of leachate allow to consider passive treatments of residual emissions. The kinetic of contaminant concentration decrease in leachate is rather slow. Thus, passive treatment will generally not be sufficient to reach a level of leachate quality for direct discharge in environment during this period. Different treatments could eventually accelerate degradation of residual organic matter (aeration, bioreactor) but these treatments are used for pilot studies or few very specific cases. Therefore, the presence of a leachate residual source is common. Question is how to assess risk coming from this situation.

2. METHODOLOGY

2.1 Start Point of national WG

To build a methodology for assessing the two phases of the aftercare period (active and passive phases), to prepare the report of aftercare completion and to help the regulators to appreciate level of risk to human health and environment, a national french WG starts in March 2017 concerning the “end of aftercare/monitoring phase”.

Start point of workgroup is a mixed Evaluation of Post Closure Care (EPCC, Crest & al, 2012) / risk analysis methodology to assess completion criteria for aftercare. EPCC methodology allows to consider short-term period (during and at the end of first phase aftercare period) and risk analysis will deal with long-term period (second phase, which could only be addressed with risk analysis and modelling).

2.2 Points to consider

The beginning of studies and WG concerning the end of aftercare was related to the general french discussions concerning the end of the monitoring phase for contaminated sites. IWWG have been discussing theses issues since the creation of the sustainable landfill WG and the end of aftercare was the specific subject of two ICLRS sessions in the past (2012).

The WG will consider accidental risk (flooding, stability, erosion) and chronic risk (coming from long-term residual emissions) for modules of EPCC approach. Even if a site-specific assessment would be required, goals of this WG are to give a framework for aftercare completion. It will deal with results of different measurements, quality of these measurements and will promote a gradual risk analysis, from maximizing approaches (water infiltration without barriers and stable sources) to the use of more precise estimations using the decay of sources, specific geochemical and attenuation parameters.

One problem of site-specific assessment will be definition of fluxes coming from different parts of landfill bodies, in order to evaluate real fluxes coming from different levels of wastes. A more precise water balance, the assessment of the duration of barriers (including cover, geocomposite liner) and effectiveness of fluxes reduction will be needed. The knowledge of mineral and geocomposite barriers behavior coming from geotechnical and hydrogeological expertise (return of experience) will be used. Mineral and liner barriers of landfills are not directly controlled (except case of double liner barriers) and narrow leachate plumes could be difficult to control. A planning and a list of items has been proposed to the WG. A selection of data and points discussed in the WG is presented here.

2.2.1 Typology of the landfills

Three main typologies of storage have been identified: old sites with no passive barriers, which could be included in the subject of ADEME inventories and treatments (most often with a clay cover after remodeling of deposits), landfills created after the 1997 French landfill decree and very recent landfills. The methodology under construction will specifically and strictly concerns post-2016 landfills, but its more or less partial application to older sites should be considered.

There are two majors typologies concerning the landfill cell behavior. For the case of landfills with no bottom barriers, the development of the plume in the saturated zone will follow rapidly increase of the plume in the vadose zone (case n°1, Figure 1). With the new landfill cells with clay layer and liner, only specific area will produce thinner plume, which will be more complicate to catch with piezometers (case n°2, Figure 1). Moreover due to the delay of the plume

migration in the vadose and saturated soil layers, the increase of the plume will not be observed during the monitoring phase in the case n°2. The question of the location of the groundwater monitoring point (downstream piezometers) is an important issue which will be adressed by specific WG focusing on groundwater quality monitoring downstream a landfill. The leachate basins represent also potential sources of leachate migration, which were not been considered in the past.

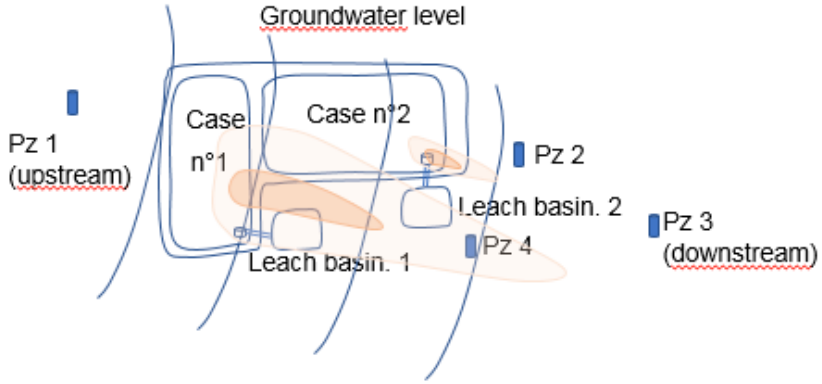

Figure 1: Presentation of two case studies for the development of the plume in groundwater

2.2.2 Time frame

We need to consider the time frame of the new regulation for the end of the aftercare period.

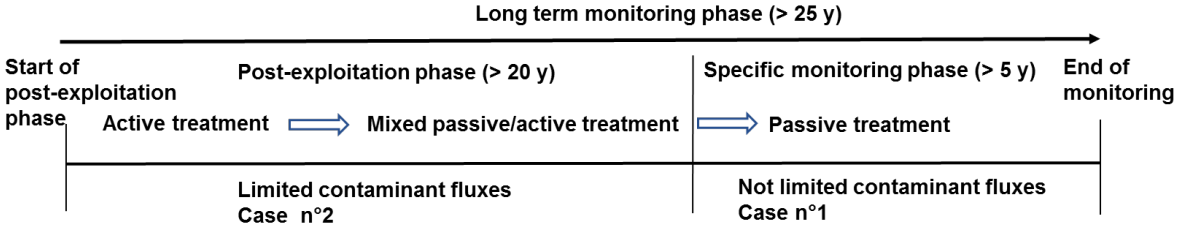

Figure 2: Time frame concerning the new regulation for aftercare period.

The ancient aftercare period of the 1997 decree is divided into two phases : the post-exploitation phase including *a minima* 20 years duration and a specific monitoring phase (*a minima* 5 years). This two new phases represent the long term monitoring phase which can be applied to specific cells. In the same landfill, oldest cells can reach more rapidly specific monitoring phase.

Duration of specific monitoring phase permits the observation of disorders linked to rising of leachate levels in case of medium permeability cover (> 10^{-7} m/s). The 5 years duration of specific monitoring phase will not allow to observe modification of leachate migration in general case : a modelling of this transient phase will be needed if leachate quality represents a threat to the quality of the groundwater.

2.2.3 Type of waste body

Quality of the landfilled waste evolves with regulation and the economical strains. A fined soil layer could be used in the past for daily cover of refuses. Each landfill represents a specific case study. The settlement of waste modifies permeability of waste and contaminant fluxes can be limited by waste body parameters and water channeling (J. Fellner, 2012). The water mass balance must be used to explore the real behavior of waste body for each cell. This point highlights importance of cell scale data.

2.2.4 Homogeneity of waste maturation and climate parameters

Homogeneity of waste maturation is linked to location of waste humidity.

Aging of landfill cover and topography will modify water balance and possibly homogeneity of moisture distribution. It is common to find old landfills with a more prononced infiltration in the center of flat area, due to maximal settlement/infiltration at these areas. In case of suspicion of large scale inhomogeneity, WG have discussed opportunities to use electrical panels (geophysics), particularly to observe/evaluate the least resistant areas. Area specific water mass balances can also give hints concerning moisture levels of the waste.

We need to consider different and specific time frame for the risk assesment, due to degradation kinetics: MSW degradation could be very fast for very low depth deposit, especially in humid and hot climate, and could be a problem for continental climate.

2.2.5 Quality of leachate

Leachate quality is very specific and variable: low organic content of new refuses, with less heavy metals and less organic materials, but with more synthetic matters (plastic) produce different leachates.

The french national survey of dangerous species in surface water have produced in 2014 analyzes of leachate discharge, coming from more than 100 landfill sites. A large amount of samples concern raw leachate without treatment, which are pumped and treated in other treatment plant. These data were processed to identify the threats to the surface water (and the groundwater). The data were sorted by the type of treatment applied, from raw leachate to reverse osmosis treatment.

More than 20 parameters were processed, from heavy metals to persistant organic pollutants concentrations.

An overview is given for the nickel parameter.

Nickel is a heavy metal which seems to be a tracer for the most mobile heavy metals. The distribution of nickel concentration in different types of leachate is presented. Boxplots give a summary of contaminant concentration of different types of leachate for the Nickel parameter (Figure 3).

Nickel distributions exhibit near-chromium behavior, but with lower values. We note the absence of mean values not included or close to the Q1 (25%) - Q3 (75%) range. Distributions in the basins and lagoons are wider, mean content remaining close to raw leachates values, while being lower. A concentration of 120 microg Ni /L seems to best represent the raw and basin leachate.

Concentration of organics are more difficult to interpret, due to the larger variations of values: larger values have a more prononced influence and means are not often in the Q1-Q3 range.

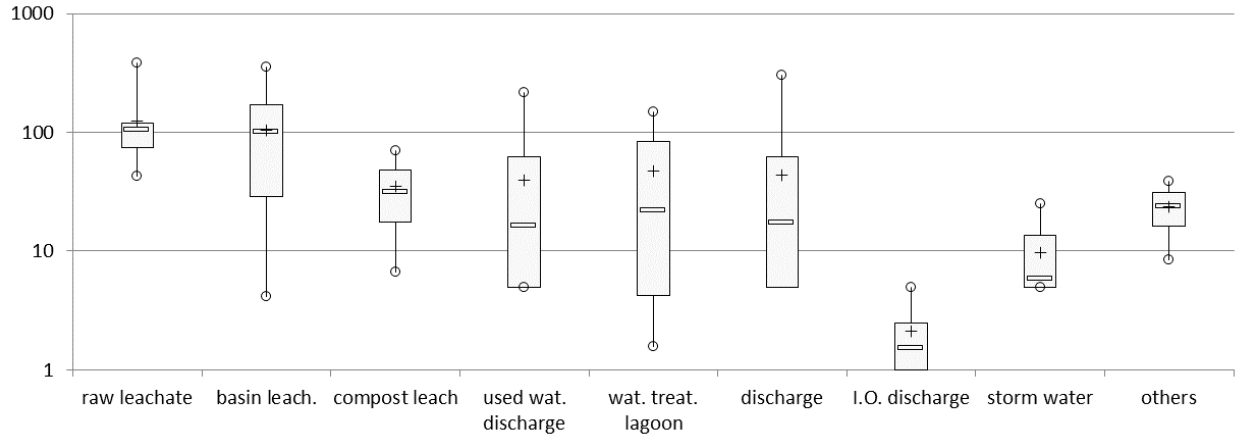

Figure 3: Distribution of the leachate concentration of nickel (219 values in microg/l)

3. RESULTS AND DISCUSSION

The first WG meeting have highligthed the need to consider the real degradation of grounwater quality in the surroundings of landfills. Degradation of the groundwater is directly linked to the quality of the leachate and contaminant fluxes. Threats to groundwater are also dependant to potential source terms and the kinetics of contaminant release. The attenuation of contaminants in the vadose layers also plays an important factor, which reduces the number of cases of groundwater degradation.

To consider more precisely role of different parameters, a return of experience of ancient landfills (with more than 15 years monitoring period) is planned in the agenda of the WG.

The WG needs to consider constrains for different landfill aftercare options and abilities to achieve or not a concentration level of contaminants in leachate (which is linked to contaminant fluxes to groundwater). Two other WG concerning groundwater monitoring and landfill cover guidelines will produce data concerning the major leachate tracers and minimum requirements for cover. It seems that duration specification of drainage layer could be a problem for long term duration (for more than 50 years).

4. CONCLUSIONS

Landfill functionnal stability needs to be discussed with the possibility of degradation of performance for covers and drainage layers (D. Laner, 2012). Degradation kinetics of drainage layers is higher than improvements of leachate quality in general case. This general case gives to the WG several possibilities and levels to explore:

- use of monitored attenuation;
- reinforcement of cover combined with a land use (solar panel, storage platform,...);
- long term use of passive treatment with or without biomass production (algae,..);
- acceleration of maturation (bioreactor);
- landfill mining.

The treatment of aged waste by bioreactor (aerobic/anaerobic) needs favorable conditions in order to reach sufficient radius of influence in waste bodies in reduced time frames. Inhomogeneity of gaseous and liquids permeabilities will complicate the assessment of maturation performance for these treatments.

Other aspects concern geotechnical risk and durability of barrier elements.

REFERENCES

Marion Crest, Jeremy Morris, Anna Åkerman, and Morton Barlaz, 2012, A Decision-Making Framework for Long-Term Leachate Management, Abstract proceedings for the 7th ICLRS, Sunderbyn, Sweden, June 25-27.

Johann Fellner, 2012, Dynamics in leachate quantity and quality at MSW landfills, Abstract proceedings for the 7th ICLRS, Sunderbyn, Sweden, June 25-27.

David Laner, 2012, How to consider long-term technical barrier performance in an aftercare completion framework?, Abstract proceedings for the 7th ICLRS, Sunderbyn, Sweden, June 25-27.