



DEPARTMENT OF  
**ECOLOGY**  
State of Washington

# **Preparing for Termination of Post-Closure Activities at Landfills Closed Under Chapter 173-304 WAC**

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For more information contact:

Waste 2 Resources Program  
P.O. Box 47600  
Olympia, WA 98504-7600

Phone: (360) 407-6900

Washington State Department of Ecology - [www.ecy.wa.gov](http://www.ecy.wa.gov)

- o Headquarters, Olympia 360-407-6000
- o Northwest Regional Office, Bellevue 425-649-7000
- o Southwest Regional Office, Olympia 360-407-6300
- o Central Regional Office, Yakima 509-575-2490
- o Eastern Regional Office, Spokane 509-329-3400

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# **Preparing for Termination of Post-Closure Activities at Landfills Closed Under Chapter 173-304 WAC**

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*by*  
*William W. Harris*

Waste 2 Resources Program  
Washington State Department of Ecology  
Olympia, Washington

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# Executive Summary

Washington State’s “Minimum Functional Standards for Solid Waste Handling,” Chapter 173-304 WAC, was issued in 1985. It provided new standards for several solid waste handling activities, including landfilling. Faced with new requirements for landfill operations, closure and post-closure planning, and financial assurance, many operators decided to close their landfills. These landfills then moved into post-closure maintenance and monitoring under Chapter 173-304.

Ecology estimates there are more than 60 closed landfills with post-closure permits issued under Chapter 173-304 WAC. These include municipal solid waste, limited purpose, and woodwaste landfills. Many of these landfills are nearing the 20-year point in their post-closure phase.

This document provides information on procedures and requirements for ending post-closure. It discusses approaches operators and permitting agencies may use to decide when a landfill is ready to end post-closure. This document answers the following questions:

- What are the responsibilities of a facility operator during post-closure?
- When can a facility operator end post-closure?
- What are the responsibilities of a facility operator, the solid waste permitting agency, and Ecology for ending post-closure?
- What information does an operator need to provide for a decision to end post-closure?
- How should information be evaluated?
- What happens to a facility when post-closure ends?

# Post-Closure Activities

## Administrative Requirements

During the post-closure phase for landfills closed under Chapter 173-304 WAC, operators must address maintenance and monitoring needs of the facility following closure. Administrative requirements for post-closure involve three major components:

1. Post-closure plan.
2. Estimate of the total cost of completing post-closure activities for the landfill for at least a 20-year post-closure period.
3. Financial assurance account with sufficient funding to pay costs of post-closure activities over the duration of the landfill's post-closure phase.

Operators should review these components annually throughout a facility's post-closure phase. They may need to adjust them to accommodate the facility's progress toward meeting the criteria for ending post-closure.

The solid waste permit provides the mechanism for the solid waste permitting agency to ensure administrative requirements are met. The permit is also a means to establish the permitting agency's expectations for activities the operator should carry out to assess if the facility is ready to end post-closure. When a facility ends post-closure, the operator is no longer required by a solid waste permit to maintain and monitor the facility's systems for collecting and managing gas, leachate, surface water or groundwater.

## Regulatory Agency Roles

Solid waste permitting agencies have sole authority to authorize ending post-closure activities under Chapter 173-304 WAC. Ecology's Waste 2 Resources Program can provide technical assistance to a solid waste permitting agency as it considers an operator's proposal to end post-closure activities.

If a solid waste facility ends post-closure activities but later presents a threat to human health or the environment, Ecology may still take actions under other authorities. Those include the Water Pollution Control Act or the Model Toxics Control Act.

## Defining End of Post-Closure

Although Chapter 173-304 WAC refers to a 20-year period in connection with post-closure activities and for financial assurance planning, the regulation's end-point for post-closure activities is not based on a specific length of time. Section 173-304-407(6) states:

*“Each owner or operator shall provide post-closure activities to allow for continued facility maintenance and monitoring of air, land, and water as long as necessary for the facility to stabilize and to protect human health and the environment.”*

Chapter 173-304 WAC refers to a stabilized site as the end-point for the post-closure phase of a landfill in several other places. Section 173-304-100(59) defines post-closure:

*“Post-closure means the requirements placed upon disposal sites after closure to ensure their environmental safety for at least a twenty-year period or until the site becomes stabilized (i.e., little or no settlement, gas production, or leachate generation).”*

Section 173-304-407(7) describes the activities that operators must address in a post-closure plan. Paragraph (a) of this section states:

*“Each owner or operator shall develop, keep and abide by a post-closure plan approved as a part of the permitting process in WAC 173–304–600. The post-closure plan shall address facility maintenance and monitoring activities for at least a twenty-year period or until the site becomes stabilized (i.e., little or no settlement, gas production or leachate generation), and monitoring of groundwater, surface water, and gases can be safely discontinued.”*

Section 173-304-407(8) outlines procedures that lead up to termination of post-closure activities. Paragraphs (b) and (c) require that:

*“(b) When post-closure activities are complete, the owner or operator shall certify to the jurisdictional health department, signed by the owner or operator, and a professional engineer registered in the state of Washington stating why post-closure activities are no longer necessary (i.e., little or no settlement, gas production, or leachate generation).*

*(c) If the jurisdictional health department finds that post-closure monitoring has established that the facility is stabilized (i.e., little or no settlement, gas production, or leachate generation), the health department may authorize the owner or operator to discontinue post-closure maintenance and monitoring activities.”*

Section 173-304-467 sets the financial assurance requirements for publicly- or privately-owned facilities that accepted waste from the public. Paragraph 173-304-467(4)(a) states:

*“Each owner or operator shall prepare a written post-closure cost estimate as part of the facility post-closure plan. The post-closure cost estimate shall be in current dollars and represent the total cost of completing post-closure activities for the facility for at least a twenty-year post-closure period in accordance with the post-closure requirements in WAC 173–304–407.”*

Chapter 173-304 WAC identifies a 20-year period as a planning basis for the post-closure phase. It doesn't establish 20 years as a maximum time for post-closure activities. Rather, the solid waste permitting agency must decide if an operator can end post-closure activities based on the facility reaching a stabilized state.

# Evaluating a Facility for a Stabilized State

Chapter 173-304 WAC defines a stabilized landfill as one that exhibits “*little or no settlement, gas production or leachate generation.*” .Before considering a closed landfill for termination of its post-closure phase, it is important to note that gas and leachate management activities will often involve air emissions and water discharge permits. A landfill which still needs an air permit for emissions from gas management, or a water quality permit for discharges from leachate management generally doesn’t meet the criteria for a stabilized state.

Assessing landfills that closed under Chapter 173-304 WAC against criteria for a stabilized state can present several challenges:

- Many landfills may have gone unmonitored for settlement, except for periodic inspection to ensure the function of a final cover was not impaired.
- Chapter 173-304 WAC doesn’t require reporting of landfill gas production or leachate generation, and post-closure solid waste permits generally do not address those parameters directly.
- Many landfills simply vent gas without an air permit, and there may be no recent gas production data for them.
- Many landfills have no engineered liner or leachate collection system, so leachate production cannot be measured directly.
- Some landfills have retrofitted leachate collection systems which may collect a mixture of leachate, groundwater and run-on surface water.
- During the post-closure period, many operators requested and were granted reductions in the scope and frequency of post-closure groundwater and landfill gas monitoring by solid waste permitting agencies.

## Data

When assessing a landfill for stability, availability of data collected over an extended time is important. Knowledge about construction and operational history of the facility is also useful.

Variations in facility construction may mean there is limited data for some measures of stability. Some measures may not have been collected as part of post-closure maintenance and monitoring.

As a landfill operator and the solid waste permitting agency consider the operator’s proposal to terminate post-closure activities, they should review the data available for the facility. They should identify any gaps pertaining to:

- Settlement.
- Gas production.
- Leachate generation.
- Groundwater monitoring.



The solid waste permitting agency should consult with the local clean air agency to see if there are any ongoing activities required by an air permit for the facility. They should also check with Ecology's Water Quality Program to see if there are any water discharge permit requirements for leachate management.

## **Filling Data Gaps**

If there are gaps in the data, the operator and solid waste permitting agency should make a plan to provide the data needed to evaluate the landfill's stability. In developing the plan, the operator and solid waste permitting agency should decide if a period of confirmational monitoring is appropriate. During confirmational monitoring, frequency of monitoring may be increased and the list of monitored analytes expanded. This is to address any unresolved concerns about potential impacts of the facility on human health and the environment.

Whenever possible, direct measurements of data to support an assessment of landfill stabilization are preferred. Topographic surveys can be done periodically to identify if settlement is still occurring.

If the facility has a functional gas collection system that doesn't require an air permit, gas monitoring and flow metering can be performed at the outlet vents. Facilities with leachate collection systems that don't have water discharge permits or haven't monitored their leachate flows (e.g., unmetered discharge to a sewer system) can begin monitoring the flow rates and analyte concentrations at the point of discharge from the facility.

Facilities that lack a functional gas collection system, a competent leachate collection system, or both may need to consider surrogate measures to evaluate gas production and leachate generation. The operator and the solid waste permitting agency should reach agreement on any surrogate measures. They should also acknowledge such methods create an unavoidable degree of uncertainty about assessing the facility.

Some approaches to surrogate measures for gas production include an extrapolation from gas flux samples through the cover, or from walking gas probe surveys. Facilities might also model methane emissions using a mathematical model such as EPA's LandGEMS. However, most such models require quantification of the amounts and types of waste disposed in the landfill over its operating life. This sort of data may not be available for many facilities that closed under Chapter 173-304 WAC.

Approaches to surrogate measures for leachate production can be more challenging. For facilities with no leachate collection system, an evaluation will probably have to be made solely based on the groundwater monitoring data. Landfills with retrofitted collection systems may collect a combination of infiltrating groundwater, surface water run-on and leachate. It may be feasible to perform a hydrogeologic assessment and analysis to estimate the leachate fraction of the water collected in such a system.

Data from groundwater and surface water monitoring may be inadequate for many reasons. If there are problems with the existing analyses or reporting, it is possible more rigorous evaluation of existing data may provide sufficient certainty about groundwater and surface water conditions at the site.

However, if inadequacy of water monitoring stems from an insufficient number of sampling points, frequency of sampling, number of analyzed parameters, etc., more sampling may be required. When evaluating how much additional sampling is appropriate, key factors are:

1. If there are exceedences of groundwater protection standards or evaluation criteria.
2. If there are statistically significant differences between the up-gradient and down-gradient data.

## **Post-Closure Care Summary Report**

Ecology recommends an operator proposing to end post-closure activities provide the solid waste permitting agency with a report summarizing relevant environmental information and evaluating stability of the landfill. This will help the solid waste permitting agency assess the operator's proposal and support the permitting agency's decision. The scope of information an operator might present in a post-closure care summary report includes:

- A description of the site that includes maps with locations of landfill cells, monitoring wells, leachate and surface water sample collection points, gas probes and wells, surface water features, and other items of interest.
- A description of the landfill construction and post-construction modifications, including any variances made from the requirements of Chapter 173-304 WAC and any corrective actions taken.
- A brief history of the dates, amounts, types, and locations of deposited waste.
- A summary of land use in the vicinity of the landfill, with descriptions of potential receptors such as nearby residences, public water supply wells, rivers, and wetlands.
- A summary of landfill gas monitoring, including volumes and constituents, and any gas management activities that may have occurred under an air emissions permit.
- A history of leachate production at the site, with descriptions of any collection systems, sampling procedures, and results. If samples are believed to be a mixture of leachate, groundwater and/or run-on surface water, it would be useful to provide an estimate of the leachate fraction of the water that was collected.
- A history of settlement and cover integrity, with descriptions of any topographic surveys and visual signs of settlement (e.g., ponding, cracks, etc.), and a discussion of any actions taken to address problems.
- Information on the site hydrogeology with descriptions of the geology, hydrogeologic cross sections, drilling history, aquifers, seeps and tidal influence (if present).

- Summary tables and discussion of groundwater elevations and velocity calculations, temporal and seasonal changes, and water level contour maps representative of the four quarters of the year.
- A summary of groundwater and surface water sampling with discussion of:
  - Any changes to the monitoring plan (including whether and how changes were approved).
  - Exceedences of groundwater quality standards (Chapter 173-200 WAC) or evaluation criteria.
  - Statistical evaluation of constituent trends.

EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance* provides appropriate statistical methods for evaluating data.

- A comprehensive discussion with conclusions about site stabilization, including an evaluation of settlement and cover integrity, gas production, leachate production, and groundwater monitoring.
- A description of any potential property management program for the site when post-closure care ends, including schedules for periodic security checks, vegetation management, and possibly limited continuing monitoring.
- An update of the status of the post-closure financial assurance account.

## Evaluating Data

Chapter 173-304 WAC's criteria for establishing a landfill facility has stabilized are qualitative. Decision-makers have to exercise judgment in making their findings on individual facilities. Data presented in support of terminating post closure activities should be assessed while considering several principles:

- **Settlement and Cover Integrity.** Integrity of the cover is a critical factor in maintaining conditions within the landfill that limit production of gas and leachate. Cover integrity should not be jeopardized by future settlement, even as maintenance and monitoring activities may be discontinued.

Settlement rate data should show the cover surface slopes will remain in the range of 2 to 5 percent, and cover side slopes will remain below 33 percent. Differential settlement rates should show changes in slopes will not result in localized impairment of cover drainage, in shearing or sliding failures of the cover soils. If the cover includes a geomembrane, settlement rates should indicate the geomembrane will not be at risk to fail due to stretching or folding.

- **Leachate Production.** If leachate production can be measured or estimated with confidence, trends in volumetric and monitored analyte mass flow rates should have slopes of zero or less. Ecology's Water Quality Program should be consulted before an operator makes any changes in the point of discharge from leachate collection systems.

- **Gas Production.** If gas production can be measured or estimated with confidence, the trend in methane mass flow rate should have a slope of zero or less. Data from subsurface gas probes should show the facility is in compliance with limits for explosive gases required by Section 173-304-460(2)(b). An assessment should be made showing the facility will remain in compliance with those limits after post-closure activities end. The air permitting authority should be consulted about discontinuing any gas monitoring.
- **Groundwater Monitoring.** The groundwater monitoring well network should be able to identify direction and velocity of groundwater flow across the facility. Groundwater quality sampling results should meet groundwater protection standards of Chapter 173-200 WAC at the facility's permitted point of compliance. They should also show no statistically significant increases between upgradient and downgradient wells where concentrations of an analyte exceeds the groundwater protection standards in the upgradient wells.

Monitored analyte concentration trends should have slopes of zero or less. An assessment should be made to show the groundwater quality will comply with the groundwater protection standards at the facility's permitted point of compliance after post-closure activities end.

## After Post-Closure

Under Chapter 173-304 WAC, a facility no longer requires a solid waste permit when the solid waste permitting agency authorizes discontinuing post-closure activities. The operator should have recorded the presence of a landfill on the property with the county auditor at the time of closure. Requirements for recording are in Section 173-304-406(6):

*“Maps and a statement of fact concerning the location of the disposal site shall be recorded as part of the deed with the county auditor not later than three months after closure. Records and plans specifying solid waste amounts, location and periods of operation shall be submitted to the local zoning authority or the authority with jurisdiction over land use and be made available for inspection.”*

The solid waste permitting agency should ensure the operator makes that recording before conclusion of post-closure activities.

**While there is no requirement for an operator to provide additional care of a facility after authorized by the permitting agency to end post-closure, the operator is still responsible to ensure the property remains in compliance with all applicable local and state requirements.**

## Addendum to

### “Preparing for Termination of Post-Closure Activities at Landfills Closed Under Chapter 173-304 WAC”

Prepared August 2012, Revised January 2013

Landfill Owners, Operators and Jurisdictional Health Authorities:

In February 2011, the Department of Ecology (Ecology) published “Preparing for Termination of Post-Closure Activities at Landfills Closed Under Chapter 173-304 WAC” (Publication No. 11-07-006). That document provides Ecology’s recommendations on information a landfill owner or operator could submit to make a case for ending post-closure care. This document provides more detail on the technical information expectations.

As required by WAC 173-304-407(8)(b and c), to end post-closure care, an owner/operator and professional engineer need to demonstrate that a landfill is stable by showing there is little or no settlement, gas production or leachate generation. This document attempts to answer the questions:

1. How should a facility measure settlement to show there is “little or no” settlement?
2. How should a facility monitor landfill gas to show there is “little or no” gas production?
3. How should a facility measure leachate to show there is “little or no” leachate generation?

### Settlement

Ideally, an owner/operator will have surveyed a landfill’s cap a few times through the post-closure period in order to show settlement has minimized. If such data does not exist, Ecology recommends an owner/operator conduct at least two benchmark surveys at least two years apart. When surveying, an owner/operator should:

- Use survey points from fixed points on the closure cap. An owner/operator should use permanent markers, such as a rod of rebar, to denote survey points – taking care not to punch holes through anti-infiltration layers or geomembranes.
- Measure one point for every 20,000 square feet and additional points to cover anomalies such as dead vegetation or depressions.
- Use equipment that is precise to within ½ inch.

A landfill is experiencing little or no settlement if:

- It has a uniform slope between 2% and 33% and generally maintains design slopes.
- Site inspections show no evidence of differential settlement.
- The settlement trend curve approaches a zero slope.
- Uniform settlement is less than ½ inch over a two-year period.

An owner/operator should submit information on:

- ✓ Type of survey.
- ✓ Images showing the location and number of survey points.
- ✓ Survey point markers used.
- ✓ Measuring equipment used, including its precision and accuracy.
- ✓ Dates and results of surveys.
- ✓ Trend curves.
- ✓ An explanation by the owner/operator and a professional engineer licensed in the state of Washington of how data shows the landfill is experiencing little or no settlement as described above.

## Landfill Gas

Ecology recommends an owner/operator measure landfill gas at a frequency approved in the post-closure plan at vents within the landfill, perimeter monitoring probes, vaults and enclosed spaces, and at landfill surfaces where plants are stressed or absent. When measuring gas, an owner/operator should:

- Use equipment that can measure to 0.1% methane.
- Calibrate and warm up equipment according to manufacturer instructions prior to each monitoring event.
- Close holes or cracks in vent pipes to prevent air intrusion and place probe far enough into vent pipes to avoid ambient air dilution (three or more feet of probe length should be fine).
- Monitor for a long enough time to remove air from equipment and get a stable reading, sometimes described in manufacturer instructions.
- Measure concentrations during periods of steady or falling barometric pressure to ensure gas is exiting the landfill.

A landfill is experiencing little or no gas production if:

- Gas concentrations at all monitoring points are below regulatory limits for the last eight consecutive sampling events, including:
  - On-site structures: 25% LEL (for methane, 25% LEL is 1.25% by volume)
  - Off-site structures, if applicable: 100 ppm methane
  - Property boundary: 100% LEL (for methane, 100% LEL is 5% by volume)
- Gas concentrations in vent pipes during periods of steady or falling barometric pressure are below 25% LEL for methane for the last eight consecutive sampling events
- Analysis of data shows statistically significant steady or declining trends in concentration.
- There are no ongoing requirements from the air permit authority beyond solid waste requirements.

There are situations where gas production is over 25% LEL at gas vent pipes, but a landfill otherwise appears to be stable. WAC 173-304 allows variances from rule requirements when “solid waste handling practices or location do not endanger public health, safety or the environment” and when compliance “would produce hardship without equal or greater benefit to the public.” A variance from showing a facility meets the standard of little or no gas production may be appropriate. In such circumstances, Ecology recommends that the owner/operator place access controls and use restrictions on the property through an environmental covenant and submit proposed language in a variance request. WAC 173-304 places no restrictions on use of the property once a jurisdictional health department approves the ending of post-closure care so it is appropriate to prevent human contact if there is ongoing production of landfill gas.

An owner/operator should submit information on:

- ✓ Monitoring procedures, including equipment used and its precision, calibration procedure and frequency, equipment warm-up, placement of probe at each type of monitoring location and duration of measurements.
- ✓ Dates, times and the percent of explosive gases (i.e. methane) measured at each location.
- ✓ Barometric pressure with trend (rising, steady or falling) at the time of measurement. Go to [weatherspark.com](http://weatherspark.com), or others, for this information. Specify source of pressure data.
- ✓ Statistically significant trend data.
- ✓ An explanation by the owner/operator and a professional engineer licensed in the state of Washington of how data shows the landfill is experiencing little or no gas production as described above.

## Leachate Generation

Ecology recommends an owner/operator measure and complete statistical analyses on leachate or groundwater samples as described in approved sampling and analysis, quality assurance or post-closure plans. An owner/operator may show that a landfill is producing little or no leachate in many ways, depending on whether they collect leachate, discharge leachate, monitor lysimeters or monitor groundwater.

A landfill is experiencing little or no leachate production if:

- For landfills with leachate lagoons, volumes of liquids have reduced over time (at least two years of regular volume measurements) or accumulated liquids are primarily the result of precipitation falling on lagoons. Landfills that produce a slightly higher volume than would be expected from precipitation alone, but that evaporate naturally (no control equipment), may also be considered to be producing little leachate.
- For landfills linked with a discharge permit, the discharge permit authority no longer requires a discharge permit.
- For landfills with lysimeters, there have been no measurable amounts of liquid accumulation over the last two years of regular monitoring.
- For landfills with groundwater monitoring, there have been no recent or ongoing exceedances of Chapter 173-200 WAC criteria for parameters specified in approved post-closure plans from at least semi-annual groundwater monitoring. In addition, through statistical analyses, trend slopes have been zero or less over a statistically significant period (generally the latest eight consecutive sampling events) and groundwater data does not show other signs of potential negative landfill impacts. Generally, Ecology will not support ending post-closure care for any landfill with existing groundwater contamination. (Information regarding methods of analyses is available in “*Guidance for Groundwater Monitoring at Landfills and Other Facilities Regulated under Chapters 173-304, 173-306, 173-350 and 173-351 WAC*” available at <https://fortress.wa.gov/ecy/publications/publications/1207072.pdf>.)

An owner/operator should submit information on:

- ✓ Monitoring procedures, including equipment and measuring tools used.
- ✓ Dates and results of monitoring events.
- ✓ For landfills linked with discharge permits, information from the discharge permit authority that shows a discharge permit is no longer required.
- ✓ For groundwater monitoring, comparisons with Chapter 173-200 WAC criteria, statistical trend analyses, comparisons of upgradient and downgradient water quality data, and a discussion of any potential groundwater contamination.
- ✓ An explanation by the owner/operator and a professional engineer licensed in the state of Washington of how data shows the landfill is experiencing little or no leachate production as described above.

If you have questions about the above recommendations, please call your regional Ecology Waste 2 Resources Program staff. They would be happy to answer any questions or work with you on alternative ways to show stability if the above information is difficult or impossible to obtain.