May 18, 2021

Washington State Department of Ecology
Central Regional Office
1250 West Alder Street
Union Gap, WA 98903-0009

Attn: Jennifer Lind

Transmitted via email to: *jeli461@ecy.wa.gov*

Re: Notification of Change to Landfill Gas Barrier Design
Interim Action Work Plan Implementation – City of Yakima Landfill Site Roadway Project
Agreed Order No. DE 15861

Dear Ms. Lind:

On behalf of the City of Yakima (City), Landau Associates, Inc. (LAI) is submitting this letter provide notification and documentation to the Washington State Department of Ecology (Ecology) that a minor design change to the landfill gas (LFG) barrier is being approved by LAI and the City for implementation by Halme Construction (Contractor) for the Yakima Landfill roadway project (roadway project). As described below, this design change is consistent with the Interim Action Work Plan (IAWP) for the roadway project, dated July 29, 2019.

Background

Prior to the project engineering designs being published for roadway project bidding, LAI was working with the primary roadway civil design team (Lochner Engineering) and identified several constructability issues related to the conceptual designs for the LFG barrier membrane as presented in the IAWP. These issues were described in a letter from LAI to Ecology dated April 1, 2020, which also included an LAI request for approval from Ecology to eliminate the plastic membrane as the primary barrier material and replace it with a vertical low-permeability soil LFG barrier (low-permeability wall) on either side of the roadway alignment. Based on this request letter and other associated email correspondence, Ecology stated in an April 21, 2020 letter that "the proposed conceptual approach is not inconsistent with the approved Interim Action Work Plan;" that "the suitability of the new conceptual approach will be determined based on compliance with all applicable regulations, and meeting performance objectives, that is, preventing lateral migration of landfill gas;" and finally that "In Ecology's opinion, there is nothing precluding the City/Landau from proceeding with the design of the vertical landfill gas barrier system in lieu of the barrier system that was proposed in the IAWP."

Based on Ecology's stated opinion and suitability criteria, the designs and specifications for the low-permeability wall were completed and included in the final construction contract documents for the

roadway project. The primary elements of the low-permeability wall design/specifications included the following:

- Low-permeability wall dimensions:
  - Nominal width: 4 feet (ft)
  - Height: variable, generally extending from contact with native soil beneath the municipal solid waste (MSW)/wood debris to final grade of backfilled excavation
  - Length/placement: generally located at the outer edge of the City-owned roadway right-of-way (ROW) and extending around the perimeter of the MSW excavation.
- Low-permeability soil properties:
  - Soil classification: ML, MH, CL, or CH soil as defined by the Unified Soil Classification System.
  - In-place hydraulic conductivity: equal to or less than 1×10^{-6} centimeters per second (cm/sec).
  - Grain-size distribution: minimum of 90 percent of the soil by weight shall pass a #4 sieve; minimum of 40 percent of the soil by weight shall pass a #200 sieve; minimum of 20 percent of the soil by weight shall be less than 0.002 mm “clay” size.
  - Plasticity index: greater than 10 percent, but less than 40 percent.
- Low-permeability soil moisture and compaction criteria and requirements:
  - Contractor shall prepare hydraulic conductivity curve-defining densities and moisture content needed to achieve specified hydraulic conductivity covering range of densities (85–90 percent of modified Proctor) and moisture contents (optimum to 3 percent wet of optimum).
  - Placement for compaction: 6- to 8-inch lifts.
  - Compaction: compacted until the in-place density and moisture content are within the acceptable range to achieve the specified hydraulic conductivity.

These design criteria are consistent with accepted landfill design practices, compliant with applicable regulations, and provide an equivalent level of performance for mitigating LFG into the roadway ROW as the low-permeability membrane concept.

Modified Design Criteria

LAI is approving a minor modification to the design criteria for the low-permeability wall, consisting of changing the nominal width of the wall from 4 ft to 3 ft (see attached revised project design Drawing ES1). All other design criteria for the low-permeability wall will remain unchanged. This design change still provides for a design with anticipated performance that is consistent with the objectives of the IAWP.

The reason for the design criteria modification is based on the Contractor’s chosen means and methods for construction of the low-permeability wall (which was not specified in the contract

documents to allow the Contractor flexibility in construction implementation in conjunction with the backfilling and compaction of the remainder of the excavation with common borrow gravel). The Contractor's elected means and methods of construction generally consist of placing and compacting common borrow gravel (gravel) across the entire MSW/wood debris excavation limits in 4-ft layers, then excavating a 4-ft-deep and 4-ft-wide trench along the low-permeability wall alignment, then placing and compacting the low-permeability soil within the trench per the technical specifications. This process is repeated across the excavation limits until the fill and low-permeability reach final grade.

Through this method of construction, the Contractor has been able to successfully meet the design specifications for the low-permeability wall; however, due to the inability of the Contractor to maintain vertical side walls of the trench into the gravel backfill, the average width of the nominal 4-ft-wide low-permeability wall has been more than 5 ft for each 4-ft-deep section of the wall. This is resulting in a costly material overage of around 30–35 percent of imported low-permeability soil during construction of the bottom 4–8 ft of the wall.

To minimize the overage during construction of the remainder of the low-permeability wall, the modified nominal wall width of 3 ft has been evaluated and is being approved by LAI based on the following factors:

- Based on the Contractor's construction means and methods for the low-permeability wall, at a nominal width of 3 ft, the actual average width of the wall will be around 4 ft across each 4-ft-deep section (as a result of the same non-vertical trench sidewall issue that is causing the current material overages).
- Contractor's test results for the actual soil being used for construction of the low-permeability wall indicate that a hydraulic conductivity of around 2×10^{-7} can be achieved when the moisture content is between 19 and 29 percent and compaction is at least 90 percent of its maximum in-place dry density of 107 pounds per cubic foot (pcf; or about 96.3 pcf). Based on field quality assurance testing during installation, the Contractor has consistently met these moisture and density criteria. This resulting hydraulic conductivity is nearly an order of magnitude lower than the specified hydraulic conductivity; thereby, resulting in a less permeable and more effective LFG barrier than required to meet the LFG migration mitigation objectives for the low-permeability wall.
- The original wall width design criteria assumed the LFG pressures on the outside of the barrier will be high, similar to what is associated with larger landfills with recent MSW placement. Based on this assumption, all of the low-permeability wall design criteria specified (including the wall width) are considered conservative because the older age and small quantity of waste at this landfill result in actual LFG pressures generated that are relatively low.
- There are no State of Washington or US Environmental Protection Agency regulatory criteria for vertical LFG barriers in MSW landfills. However, for landfills subject to Washington State's solid waste regulations, there are criteria for cover systems that provide protection for both surface water infiltration (to limit leachate generation), and to prevent LFG from escaping through the surface. The technical specifications for these systems are developed based on

the former design goal (limiting surface water infiltration) assuming that in accomplishing this function, the system will contain LFG as well. Minimum specifications vary depending on which Washington Administrative Code (WAC) is applicable (e.g., WAC 173-304; WAC 173-350; WAC 173-351). But generally, the required specifications range at the low end for older and smaller facilities from **2 ft** of low-permeable soil (1 x 10^{-5} cm/sec; WAC 173-304-460) to the upper end for newer and larger facilities needing a composite cover with **2 ft** of low-permeable soil paired with a geomembrane (1 x 10^{-7} cm/sec soil, 60-mil high-density polyethylene membrane; WAC 173-351-300). Based on these criteria, a **3-ft**-thick LFG barrier wall with a specified hydraulic conductivity of 1 x 10^{-6} cm/sec (and actual hydraulic conductivity that is around 2 x 10^{-7}) is considered very conservative and will result in effective mitigation of lateral LFG migration.

- The contract specifications call for installation of plastic sheeting (10-mil scrim reinforced) across the final MSW/wood debris excavation face for dust and odor control purposes. This dust/odor barrier is being left in place and buried beneath the gravel backfill for the excavation. While not explicitly intended for mitigation of LFG mitigation, this plastic sheeting will provide a relatively effective initial barrier to LFG migration from MSW/wood debris remaining outside the excavation limits toward the roadway ROW, further reducing the volume and pressure of LFG that may reach the low-permeability soil wall. Furthermore, the "wedge" of backfilled gravel borrow between the MSW/wood debris excavation provides a relatively high conductivity (e.g., average hydraulic conductivity of gravel is typically around 1 x 10^{-5} cm/sec)[1] and preferential pathway for LFG migration to ground surface prior to reaching the significantly lower permeability material of the LFG barrier wall.

Based on each of the factors described above, it is LAI's professional opinion that the minor design criteria modification described herein results in an LFG barrier with anticipated performance that is consistent with the objectives of the IAWP.

If you have any questions regarding this letter or need additional information related to the modified design criteria, please contact Bill Preston (509-576-6754) at the City or Piper Roelen (425-329-0319) at LAI.

LANDAU ASSOCIATES, INC.

Piper M. Roelen, PE
Principal

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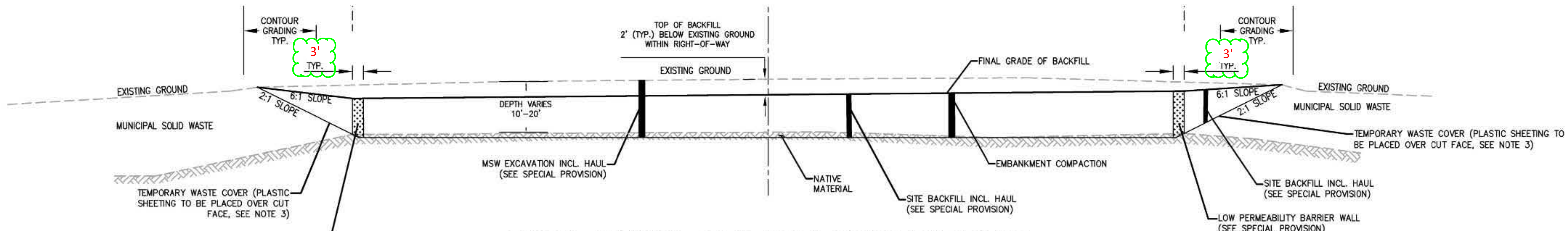
cc: Bill Preston, City of Yakima
Sara Watkins, City of Yakima
Kurt Peterson, PKG Law
Andy King, PKG Law

Attachment

Drawing ES1 (Revised) – Excavation Sections

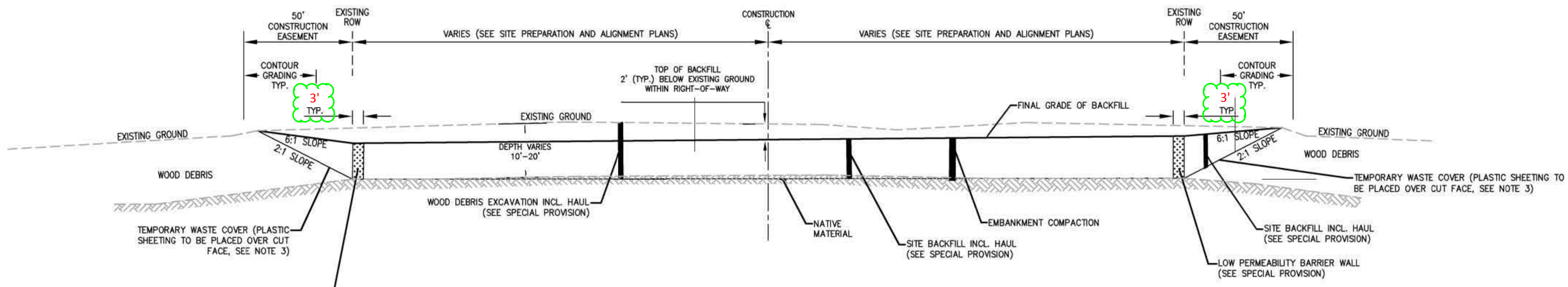
[1] Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology, John Wiley & Sons, New York, 824 p.



TYPICAL MUNICIPAL SOLID WASTE EXCAVATION SECTION

BRAVO COMPANY BLVD. 508+25 TO 519+69
CASCADE MILL PARKWAY 58+25 TO 67+00

NTS



TYPICAL WOOD DEBRIS EXCAVATION SECTION

BRAVO COMPANY BLVD. 55+50 TO 58+25
NTS

GENERAL NOTES

1. PRIOR TO PREPARATION OF THE SUB-GRADE FOR THE LOW PERMEABILITY BARRIER WALL, THE GROUNDWATER SHALL BE TEMPORARILY DEWATERED AS PROVIDED IN THE SPECIAL PROVISIONS.
2. LOW PERMEABILITY BARRIER WALL SHALL BE CONSTRUCTED BY PLACING AND COMPACTING LOW PERMEABILITY SOIL ALONG THE ALIGNMENT SHOWN ON SHEETS GP1 & GP2. THE WIDTH OF THE LOW PERMEABILITY BARRIER WALL SHALL BE NO LESS THAN 3' FEET AND THE OUTSIDE EDGE OF THE LOW PERMEABILITY BARRIER WALL SHALL NOT EXTEND BEYOND THE RIGHT-OF-WAY LIMITS.
3. TEMPORARY WASTE COVER SHALL BE PLACED OVER EXPOSED WASTE AT THE CONCLUSION OF EACH WORKING DAY. 10-MIL SCRIM-REINFORCED PLASTIC SHEETING SHALL BE USED FOR THE TEMPORARY COVER, AND SHALL BE SACRIFICIAL, COVERED AND ABANDONED IN PLACE AS BACKFILLING PROGRESSES. SEAMS SHALL OVERLAP BY A MINIMUM OF 12-INCHES. THE PLASTIC SHEETING SHALL BE ANCHORED AND SECURED AS PROVIDED IN TECHNICAL SPECIFICATIONS.

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NO.	DATE	BY	APPR.	REVISIONS
1	5/12/21	PMR		Minor Revision

APPROVED FOR CONSTRUCTION

ENGINEERING MANAGER DATE
PROJECT MANAGER DATE
PROJECT ENGINEER DATE

DESIGNED BY M.SANDOVAL
DRAWN BY C.ED
CHECKED BY D.MARIANO
APPROVED BY R.MCGAUGHEY
DATE: SEPTEMBER 2020

LOCHNER
LANDAU ASSOCIATES

CITY OF YAKIMA
BRAVO COMPANY BLVD. MSW AND WOOD DEBRIS REMOVAL
EXCAVATION SECTIONS

DRAWING NUMBER ES1
SHT 4 OF 15