# Appendix N – Quantities

N.1 Waste Volume Calculations
N.2 Soil Quantity Calculations

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# N.1 – Waste Volume Calculations

| | | | |
|---|---|---|---|
| **Client:** | **Zion Landfill, Inc.** | | |
| **Project:** | **Zion Landfill - Site 2 North Expansion** | | |
| **Project #:** | **631020105** | | |
| **Calculated by:** | **PPK** | **Date:** | **05/2022** |
| **Checked by:** | **CMS** | **Date:** | **05/2022** |

**Title: Capacity of Zion Landfill with Site 2 North Expansion**

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**Approximate Remaining Capacity of Existing Landfill**

| | | | |
|---|---|---|---|
| Remaining Capacity (as of January 1, 2021) | | 5,362,951 | airspace cubic yards (gross) |
| *Multiplied by Utilization Rate* | x | 1.10 | tons per airspace cubic yard |
| *Equals Capacity in Tons* | | 5,899,246 | tons |
| | | 5,899,000 | tons (rounded) |

**Incremental Capacity of Site 2 North Expansion (excluding existing airspace)**

| | | | |
|---|---|---|---|
| Expansion Capacity | | 12,725,719 | airspace cubic yards (gross) |
| *Multiplied by Utilization Rate* | x | 1.10 | tons per airspace cubic yard |
| *Equals Capacity in Tons* | | 13,998,291 | tons |
| | | 13,998,000 | tons (rounded) |

**Projected Capacity of Expanded Landfill (including existing airspace)**

| | | | |
|---|---|---|---|
| Existing Landfill | | 5,899,000 | tons |
| Site 2 North Expansion | + | 13,998,000 | tons |
| Total | | 19,897,000 | tons |

Notes:
1. The utilization rate indicates how much waste can be compacted into one cubic yard of airspace, inclusive of daily cover requirements. At a utilization rate of 1.10 tons per airspace cubic yard, 2,200 pounds of waste, plus daily cover, will fill one airspace cubic yard.
2. Utilization rate (1.10 tons per airspace cubic yard) based on 5-year average utilization rate (2015-2019).
3. The utilization factor and compacted density of waste at the Zion Landfill is higher relative to other landfills due to a greater proportion of waste soil materials accepted.

**Projected Throughput at Landfill** 830,000 tons per year

Notes:
1. Projected throughput similar to 5-year (2014-2018) average throughput of 822,000 tons per year. 2019 throughput at landfill was reduced due to construction of new disposal cell; therefore, 2019 throughput was not included in calculation of 5-year average throughput.

**Approximately Life of Expanded Landfill (assuming an average of 830,000 tpy)**

| | | | |
|---|---|---|---|
| Existing Landfill | | | |
| *Remaining Capacity (as of January 1, 2020)* | | 5,899,000 | tons |
| *Divided by Annual Throughput* | ÷ | 830,000 | tons per year |
| *Equals Remaining Life (years)* | | 7.1 | years |
| | | | |
| Site 2 North Expansion | | | |
| *Expansion Capacity* | | 13,998,000 | tons |
| *Divided by Annual Throughput* | ÷ | 830,000 | tons per year |
| *Equals Remaining Life (years)* | | 16.9 | years |
| | | | |
| Expanded Landfill (inclusive of existing airspace) | | | |
| *(as of January 1, 2021)* | | 24.0 | years (rounded) |
| | | | |
| Expected Closure (calendar year, rounded) | | 2044 | |

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| **Calculated by:** | **PPK** | **Date:** | **05/2022** |
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**Title: Expected Life of Zion Landfill with Site 2 North Expansion**

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**Assumptions:**

Annual Growth in Throughput: 0.0%
Capacity of Expanded Landfill (tons): 19,897,000 (as of January 1, 2021)

**TABLE E.1. PROJECTED OPERATING LIFE OF EXPANDED LANDFILL**

| Calendar Year | Analysis Period Year | Throughput (tons) | Cumulative Disposed (tons) |
|---|---|---|---|
| 2021 | 1 | 830,000 | 830,000 |
| 2022 | 2 | 830,000 | 1,660,000 |
| 2023 | 3 | 830,000 | 2,490,000 |
| 2024 | 4 | 830,000 | 3,320,000 |
| 2025 | 5 | 830,000 | 4,150,000 |
| 2026 | 6 | 830,000 | 4,980,000 |
| 2027 | 7 | 830,000 | 5,810,000 |
| 2028 | 8 | 830,000 | 6,640,000 |
| 2029 | 9 | 830,000 | 7,470,000 |
| 2030 | 10 | 830,000 | 8,300,000 |
| 2031 | 11 | 830,000 | 9,130,000 |
| 2032 | 12 | 830,000 | 9,960,000 |
| 2033 | 13 | 830,000 | 10,790,000 |
| 2034 | 14 | 830,000 | 11,620,000 |
| 2035 | 15 | 830,000 | 12,450,000 |
| 2036 | 16 | 830,000 | 13,280,000 |
| 2037 | 17 | 830,000 | 14,110,000 |
| 2038 | 18 | 830,000 | 14,940,000 |
| 2039 | 19 | 830,000 | 15,770,000 |
| 2040 | 20 | 830,000 | 16,600,000 |
| 2041 | 21 | 830,000 | 17,430,000 |
| 2042 | 22 | 830,000 | 18,260,000 |
| 2043 | 23 | 830,000 | 19,090,000 |
| 2044 | 24 | 807,000 | 19,897,000 |

# N.2 – Soil Quantity Calculations

| | |
|---|---|
| **Client:** | **Zion Landfill, Inc.** |
| **Project:** | **Zion Landfill – Site 2 North Expansion** |
| **Project #:** | **631020105** |
| **Calculated By:** | **ORC** **Date: 05/2022** |
| **Checked By:** | **CMS** **Date: 05/2022** |

**TITLE: SOIL BALANCE**

## Problem Statement

Perform a material balance to determine if there is a surplus or deficiency of soil for the proposed landfill expansion.

## Parameters Used in Calculations

| | | |
|---|---|---|
| Waste Volume | 12,725,719 | cy |
| Waste Footprint | 75.44 | acre |
| Three Dimensional Surface Area of Base Liner | 68.32 | acre |
| Three Dimensional Surface Area of Final Cover | 79.90 | acre |
| Constructed Bottom Liner Thickness | 5.00 | ft |
| Constructed Final Cover Thickness | 5.00 | ft |
| Soil Swell Over Raw Volume (Bank Volume) for Stockpile Soils | 10 | percent |
| Soil Shrinkage Under Raw Volume (Bank Volume) for Construction Soils | 5 | percent |
| Soil Shrinkage Under Stockpile Volume for Construction Soils | 15.8 | percent |
| Percentage of Airspace Consumed by Daily/Intermediate Soils | 5 | percent |
| Terrace Berm Length | 21,424 | lin. ft. |

*Notes:*
*Soil swell and shrinkage factors are used to relate how soil volumes change depending on the placement condition of the soil. For example, a 1 cy volume of soil prior to excavation will loosen and expand ("swell") when it is dug up, resulting in a 1.1 cy volume based on a swell factor of 10%. If this 1.1 cy of excavated soil is then placed in an engineered manner that includes compaction, its volume will be reduced to 0.95 cy based on a soil shrinkage factor of 5%. The difference between 1.1 cy and 0.95 cy is 15.8%.*

*Bank volume reflects the volume of soil prior to excavation. Gross volume reflects the volume of airspace without consideration of swell or shrinkage factors.*

*This calculation is approached assuming all excavated soils will be placed in a stockpile, which will then be used as a borrow source for construction soils and operating soils (daily/intermediate soils).*

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**TITLE: SOIL BALANCE**

## Calculations

Step 1: Using AutoCAD surface comparisons, identify the gross cut and fill volumes for major construction areas. Each identified construction feature is compared to existing grades as of the date of the site topographic survey to determine cut and fill volumes. It is noted that the cut and fill volumes are bank volumes and do not consider swelling factors associated with excavation or shrinkage factors associated with engineered (compacted) placement.

| Construction Feature | Cut (Gross) | Fill (Gross) |
|---|---|---|
| Developing Bottom of Excavation Grades | 4,602,960 | 15,273 |
| Screening Berms | 781 | 561,783 |
| North Stormwater Basin (Detention Basin 8) | 118,576 | 14,655 |
| Roads, Stormwater Ditches, Remaining Areas | 4,418 | 91,618 |
| **TOTAL:** | **4,726,735** | **683,329** |

Step 2: Determine the resulting volume of soil that will be stockpiled from the cut volumes listed in Step 1. It is noted that this this calculation does not consider construction of any landfill features, which is handled in future steps.

$$Stockpile\ Volume = Cut\ Volume \times (100\% + Soil\ Swell\ Factor_{Bank})$$

$$Stockpile\ Volume = 4{,}726{,}735cy \times (1.10) = \mathbf{5{,}199{,}409\ cy}$$

Step 3: Determine the volume of soil that will be required to construct the items identified in Step 1, assuming all soils come from stockpiled soils from Step 2.

$$Construction\ Volume = Fill\ Volume_{Gross} \times \left(100\% + Shrinkage\ Factor_{Stockpile\ Source}\right)$$

$$Construction\ Volume = 683{,}329\ cy \times (1.158) = \mathbf{791{,}295\ cy}$$

Step 4: Determine the volume of stockpiled soil that will be required to construct the landfill bottom liner:

$$Construction\ Volume = 3D\ Surface\ Area \times Thickness \times \left(100\% + Shrinkage\ Factor_{Stockpile\ Source}\right)$$

$$Construction\ Volume = 68.32\ acres \times {}^{43{,}560\ ft^2}/_{acre} \times 5\ ft \times (1.158) = \mathbf{638{,}191cy}$$

Step 5: Determine the volume of stockpiled soil that will be required to construct the landfill final cover:

$$Construction\ Volume = 3D\ Surface\ Area \times Thickness \times \left(100\% + Shrinkage\ Factor_{Stockpile\ Source}\right)$$

$$Construction\ Volume = 79.90\ acres \times {}^{43{,}560\ ft^2}/_{acre} \times 5\ ft \times (1.158) = \mathbf{746{,}362\ cy}$$

| | |
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**TITLE: SOIL BALANCE**

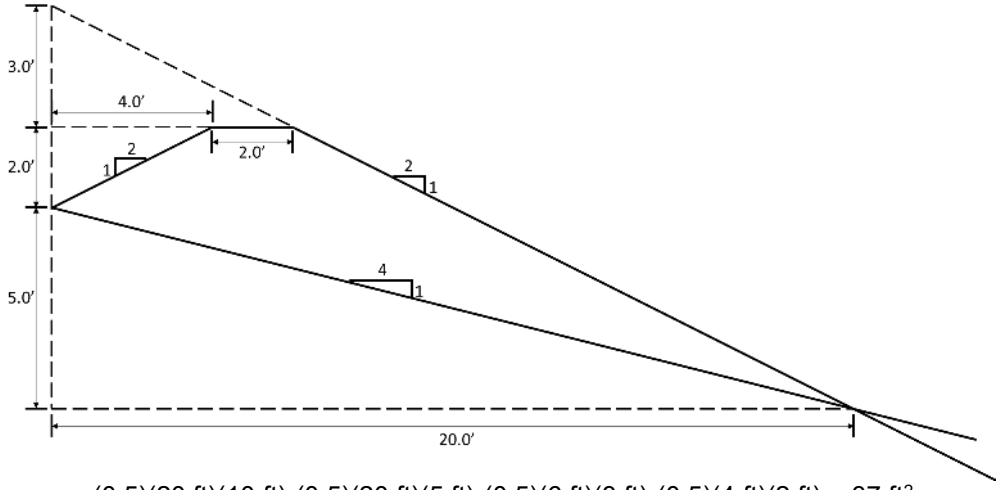
Step 6: Determine the volume of stockpiled soil that will be required for daily and intermediate soils. Note that this material is not placed in a compacted manner and therefore does not need to be adjusted by a shrinkage factor.

$$Daily\ and\ Intermediate\ Soils = Waste\ Vol. \times Percentage\ Utilized_{Daily\ and\ Intermediate}$$

$$Daily\ and\ Intermediate\ Soils = 12{,}725{,}719\ cy \times 0.05 = \mathbf{636{,}286\ cy}$$

Step 7: Determine the required volume of stockpiled soil to construct the terrace berms that will be placed on top of the final cover.

7a. Calculate the cross-sectional area of a terrace berm using the following sketch:




(0.5)(20 ft)(10 ft)-(0.5)(20 ft)(5 ft)-(0.5)(6 ft)(3 ft)-(0.5)(4 ft)(2 ft) = 37 ft$^2$

7b. Calculate the total volume of soil required for the total installed length of terrace berms:

$$Construction\ Volume = Length_{Terrace} \times Area_{Terrace} \times \left(100\% + Shrinkage\ Factor_{Stockpile\ Source}\right)$$

$$Construction\ Volume = 21{,}424\ lin.ft \times 37\ ft^2 \times (1.158) = \mathbf{33{,}998\ cy}$$

Step 8: Determine the resulting volume of stockpiled soil once soil uses described in Steps 3 through 7 are subtracted from Step 2.

$$Stockpile\ Volume_{Resultant} = Stockpile\ Volume_{Step\ 2} - Soil\ Uses_{Steps\ 3\ through\ 7}$$

$$Stockpile\ Volume_{Resultant} = 5{,}199{,}409\ \text{cy} - 791{,}295\ \text{cy} - 638{,}191\ \text{cy} - 746{,}362\ \text{cy} - 636{,}286\ \text{cy} - 33{,}998\ \text{cy} = \mathbf{2{,}353{,}277\ cy}$$

## Results

After all site construction activities are complete, the landfill expansion will produce a net total soil balance of **2,353,277 cy**.