Solar on Landfills

Scott Sheridan | 07.25.2023

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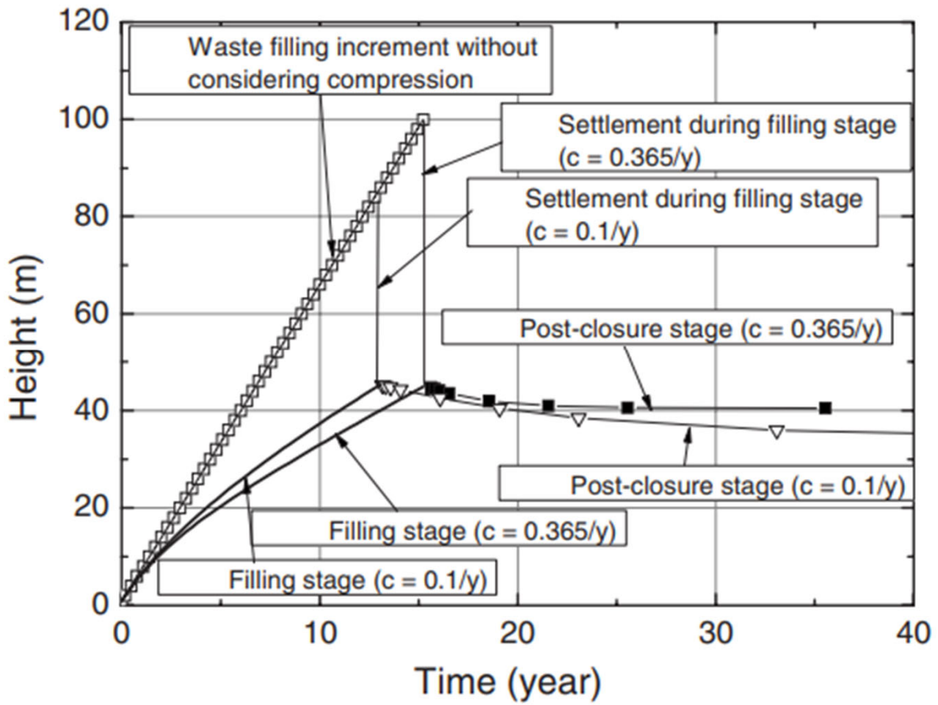
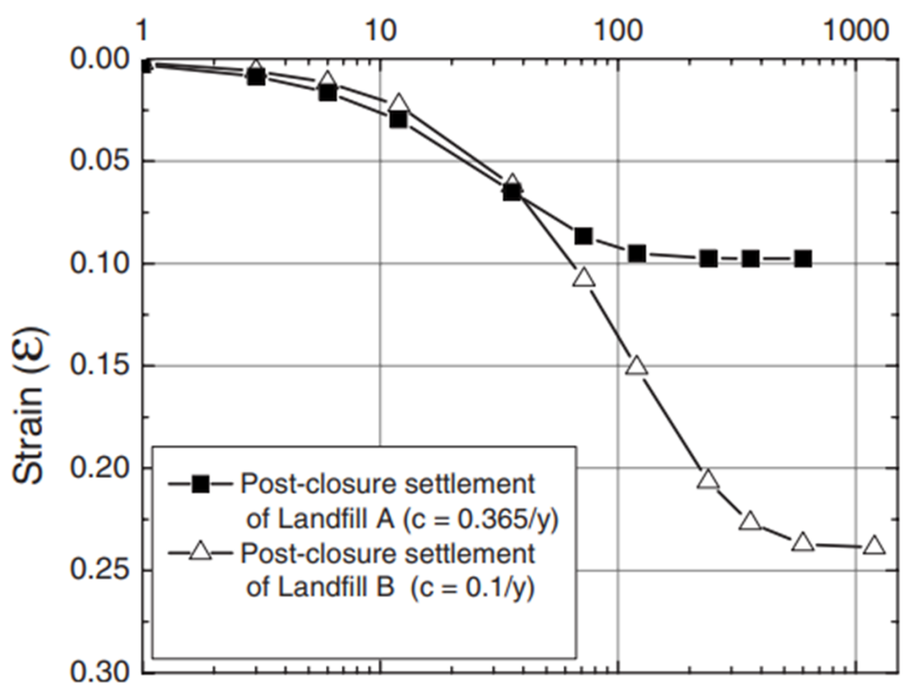
Topics Covered

- Design Considerations for Siting Solar on Landfills
- Permitting Considerations
- End of Life Management

Landfill Settlement

- Primary settlement occurs over a matter of day
- Secondary settlement occurs over years.
- The rate of secondary settlement is highly dependent on landfill conditions.



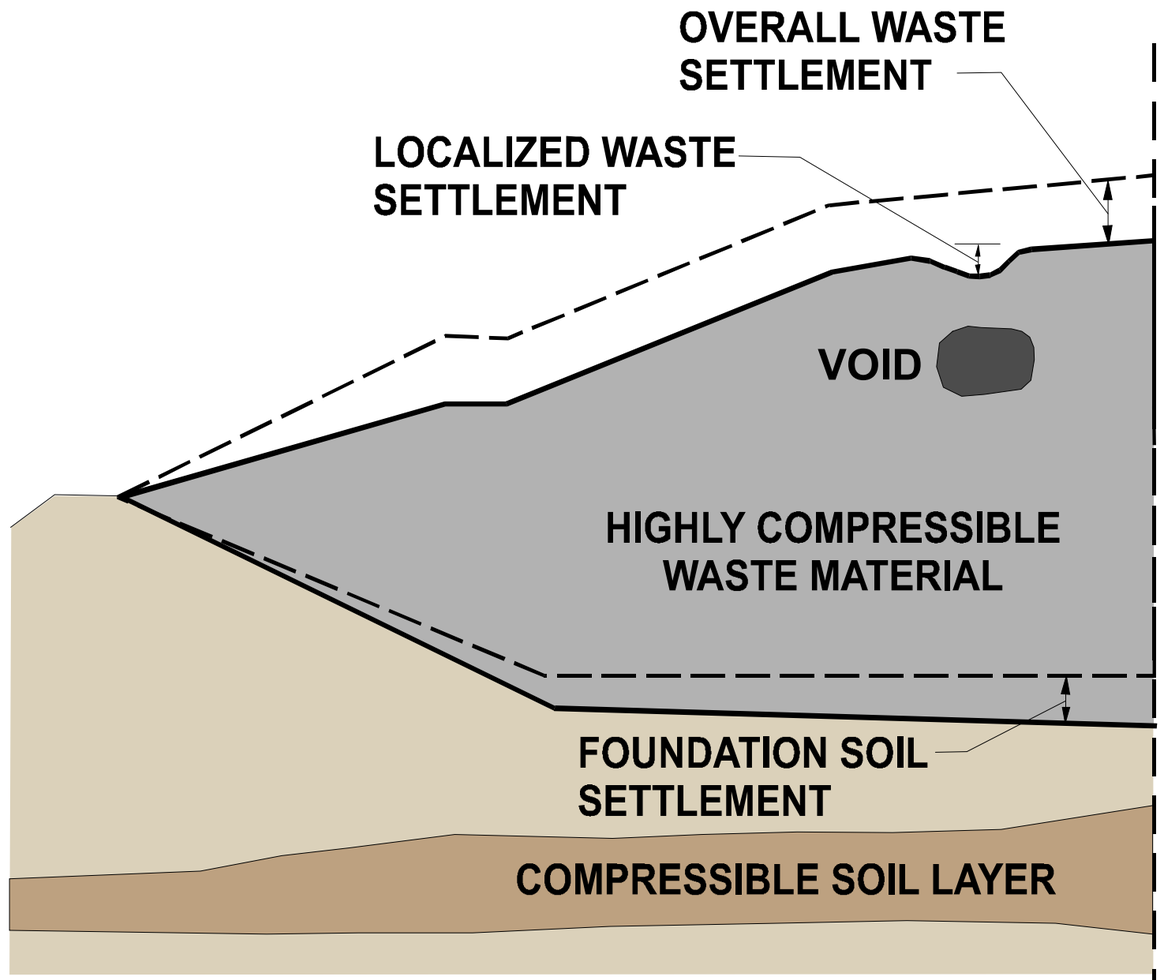


- The amount of secondary settlement that has occurred is a function of a compression index and time.

Yunmin Chen ; Han Ke; Delwyn G. Fredlund, M.ASCE; Liangtong Zhan; and Yan Xie, *Secondary Compression of Municipal Solid Wastes and a Compression Model for Predicting Settlement of Municipal Solid Waste Landfills*, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 136, No. 5, May 1, 2010

Settlement Considerations

- How much settlement has already occurred (what is the age of the waste)?
- How was the waste placed in the landfill?
- How did the LFG system function?
- How much settlement remains to occur?
- Will localized settlement impact foundations? MSW vs. CDD
- Ponding should be prevented.



Stormwater Runoff – Some Common Sense

VS

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- Stormwater runoff has increased energy and is already concentrated coming off solar panels

Stormwater Considerations

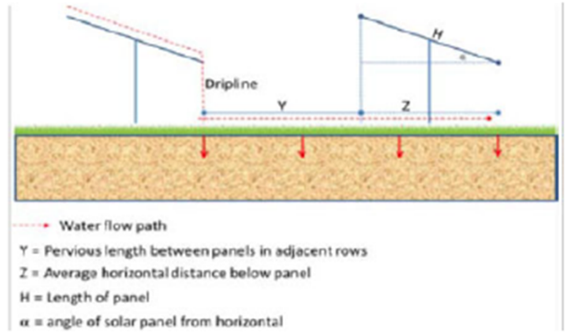
1.6% Impervious area compared to 23.5%

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
167.700	74	>75% Grass cover, Good, HSG C (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
3.390	87	Dirt roads, HSG C (1, 2, 3, 4, 5, 6, 8, 9, 10)
19.520	83	Small grain, straight row, Good, HSG C (1, 2, 3, 7, 8, 9, 10)
0.140	98	Unconnected pavement, HSG C (1, 2, 3, 8, 9, 10)
21.490	70	Woods, Good, HSG C (1, 2, 3, 6, 7, 8, 9, 10)
212.240	**75**	**TOTAL AREA**

The difference in CN was enough difference to affect design decisions.

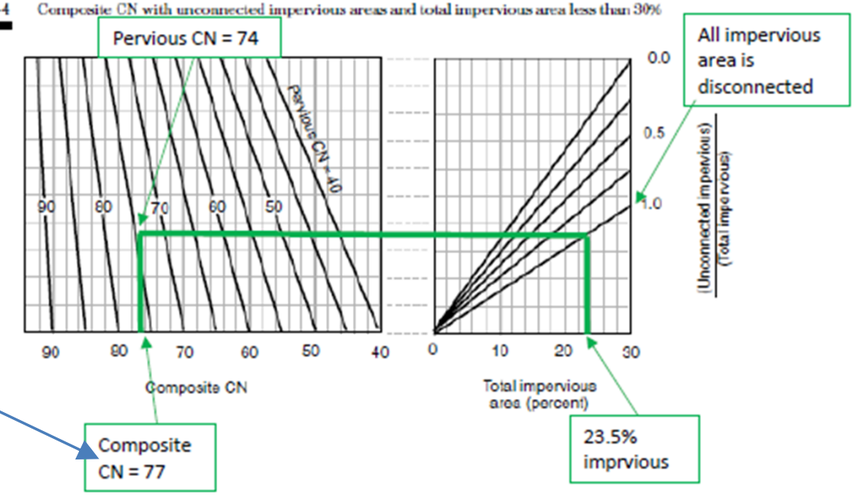
SOLAR PANEL CURVE NUMBER CALCULATIONS



Source: https://stormwater.pca.state.mn.us/index.php?title=Stormwater_management_for_solar_projects_and_determining_compliance_with_the_NPDES_construction_stormwater_permit

α-max	0 °	(maximum angle of solar panel from horizontal)
α-min	30 °	(minimum angle of solar panel from horizonatal)
H	6.43 ft	(length of panel)
Z	6.00 ft	(average horizontal distance below panel)
Y	13.57 ft	(pervious length between panels in adjacent rows)
W	3.31 ft	(width of panel)
Impervious area	19.8 sf	(per panel)
Pervious area	64.7 sf	(per panel)
Impervious area	23.5 %	(per panel)
Pervious CN	74	(HSG C, pasture/grassland/range, good)

Figure 2-4 Composite CN with unconnected impervious areas and total impervious area less than 30%



Source: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf

Stormwater Considerations

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- Check sheet flow assumptions on top of landfill (100-ft max)
  - Erosion risk
- Evaluate freeboard in diversion berms and ditches
- Evaluate downchute capacity and energy dissipators
- Check perimeter ditch and culvert capacity
- Evaluate basin capacity, riser design

Landfill Gas Management Considerations

- Passive vs. active system
- Are LFG headers and laterals surveyed?
- Is there an active LFG condensate pumping system?
- Can wellheads be remote?
- Construction risks

Permitting Considerations

- Amended Closure and Post-Closure Care Plan
  - Design calculations – stormwater, settlement, geosynthetics
  - New design details – cap system, stormwater, LFG
  - New FA estimate
  - Post-closure use
    - Inspections and maintenance
    - End-of-life plans
- Land Disturbance Permit/VSMP Coverage

End of Life Management

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- Some states are wrestling with what to do to manage solar waste.
  - Recycling – limited outlets
    - Recycling contractors, e.g., We Recycle Solar, First Solar
  - WA – Require manufacturers to fund recycling programs in 2025
    - Universal Waste? – not federally. Only CA, HI have added.
    - NC Guidance
- ASTM Method for TCLP procedure.
  - ASTM E3325-21 Standard Practice for Sampling of Solar Photovoltaic Modules for Toxicity Testing