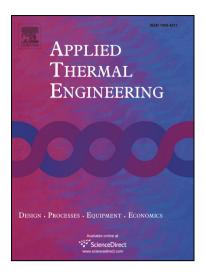
### Accepted Manuscript

Numerical simulation of ground source heat pump system considering unsaturated soil properties and groundwater flow

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PII: DOI:	S1359-4311(17)36506-7 https://doi.org/10.1016/j.applthermaleng.2018.04.142
Reference:	ATE 12139
To appear in:	Applied Thermal Engineering
Received Date:	10 October 2017
Revised Date:	12 April 2018
Accepted Date:	30 April 2018



Please cite this article as: C. Li, P. John Cleall, J. Mao, J. Javier Muñoz-Criollo, Numerical simulation of ground source heat pump system considering unsaturated soil properties and groundwater flow, *Applied Thermal Engineering* (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.04.142

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## ACCEPTED MANUSCRIPT

#### Numerical simulation of ground source heat pump system considering unsaturated soil

#### properties and groundwater flow

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Keywords: Ground source heat pump, Borehole heat exchanger, Unsaturated soil, Groundwater flow

## ABSTRACT

This paper analyzes the influence of unsaturated soil properties and groundwater flow on the performance of ground source heat pump (GSHP) systems. A mathematical model of GSHP systems, which considers the influence varying unsaturated soil thermal properties, groundwater table depth and saturated groundwater flow, is introduced and coupled to a heat pump model to consider dynamically-changing loads due to specific heat pump coefficient of performance (COP) characteristics. The model is validated against experiment results and an analytical model reported by others. Finally, numerical simulations are performed to investigate the effect of inclusion of a heat pump, moisture content variations, groundwater table fluctuations and groundwater flow rates on the performance of the GSHP system. Results show that neglecting

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