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| **UTC Project Information – Project 2.11** |
| Project Title |  Culvert Rehabilitation using 3D Printed Diffusers  |
| University |  University of Maine |
| Principal Investigator |  Roberto Lopez-Anido |
| PI Contact Information | rla@maine.edu |
| Co-PI(s) | Sunil Bhandari |
| Co-PI Contact Information | sunil.bhandari@maine.edu |
| Funding Source(s) and Amounts Provided  | UMaine (Phases I and II + Phase III) : $158,467+ $142,566MaineDOT(Phase I): $6,500NHDOT (Phase III) : $20,000  |
| Total Project Cost | $327,533 |
| Agency ID or Contract No |  69A3551847101 |
| Start and End Dates |  07-01-2020 to 06-30-2022 |
| Brief Description of Research Project | **What are** [**culvert diffusers**](https://research.transportation.org/wp-content/uploads/sites/31/2020/07/Sweet16Presentation-Maine-Culvert-Diffuser.pptx) **and why are they used?*** Culverts are installed in highways to control water flows
* Culverts deteriorate with age and need repairs.

**Current culvert retrofit technology:** * Use slip-liners
* Problem: reduction of the cross-section and hence the capacity of the culvert.

**New culvert outlet diffusers technology:*** Increase the culvert capacity and compensate for the losses due to liner retrofit
* Reduce outlet flow velocity and minimize erosion.

**Project objectives:*** Explore the feasibility of using large scale 3D printing to manufacture culvert outlet diffusers with site-specific optimized designs.
* Design and manufacture an experimental 3D printed culvert diffuser prototype to evaluate hydraulic capacity at the site
* Assess the use of bio-based renewable polymer composites for manufacturing culvert diffusers.
* Explore segmental manufacturing of 3D printed culvert diffusers.
* Evaluate the performance of 3D printed culvert diffuser in the field.
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| Describe Implementation of Research Outcomes (or why not implemented)  |  A person standing next to large barrels  Description automatically generated with low confidence

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| 3D printed culvert outlet diffuser segments. | Assembled culvert diffuser segments |

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| Impacts/Benefits of Implementation (actual, not anticipated) | * Design of the diffuser is unique depending on the culvert and the site conditions.
* Significant cost reduction to current manufacturing methods.
* 3D printing is more cost effective for larger parts.
* Segmental manufacturing of long and narrow parts enables faster manufacturing times.
* Optimized designs of culvert diffusers based on site-specific hydraulic conditions can be manufactured using large-scale 3D printing at lower cost than current methods.
* Hydraulic performance evaluation in the field, as well as ease of installation and durability have to be demonstrated for technology transfer.
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| Web Links* Reports
* Project website
 | Bhandari, S., Lopez-Anido, R.A., Anderson, J. and Mann, A. “Large-scale extrusion-based 3D printing for highway culvert rehabilitation,” [ANTEC 2021](https://www.4spe.org/i4a/pages/index.cfm?pageid=6098), Society of Plastic Engineers, Hybrid Edition, Mar. 22-23, 2021. |