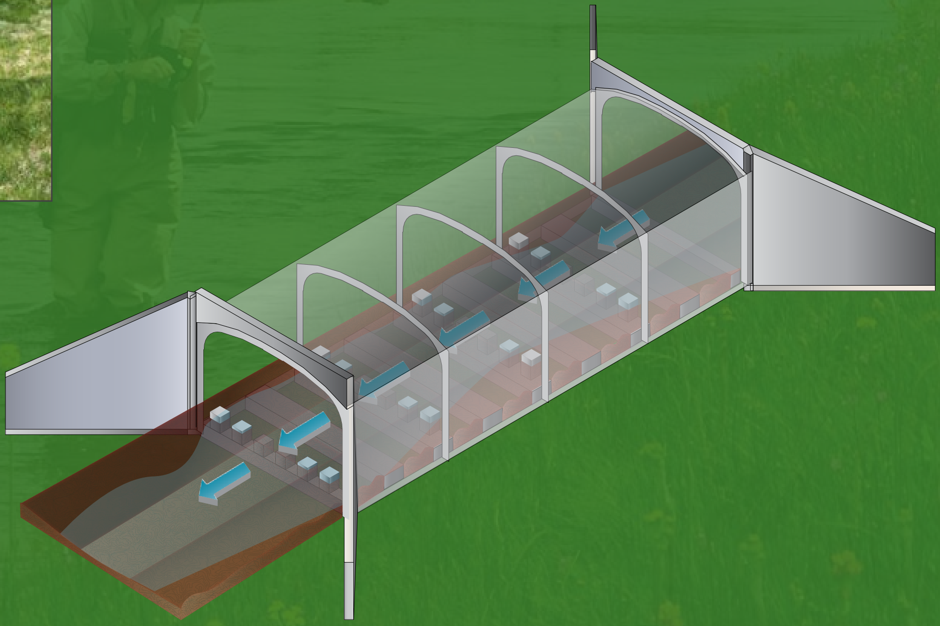
CONTECH®
ENGINEERED SOLUTIONS

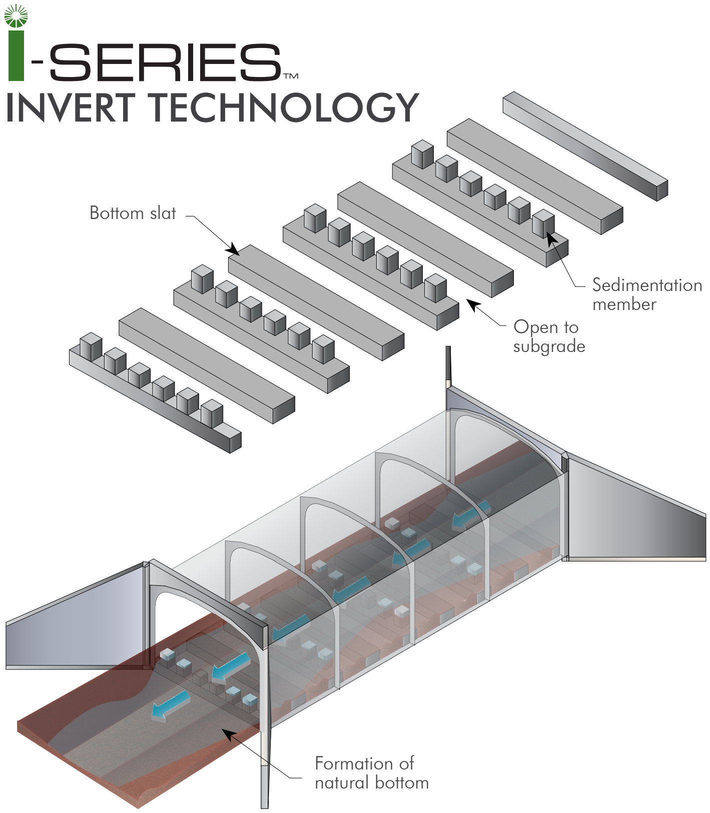
# i-Series™ Invert Technology

- Fish Passage (AOP)
- Stream Ecology
- Stream Biology



800-338-1122 | www.ContechES.com

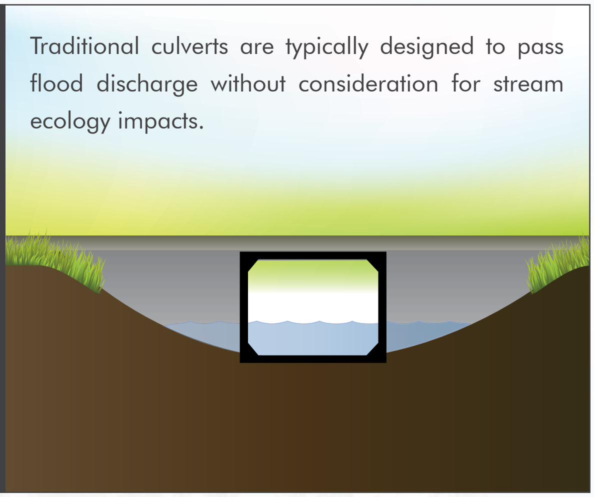
A.




## I-SERIES INVERT TECHNOLOGY

Integration of **i-Series™** invert technology promotes sedimentation of natural streambed material. This creates a natural bottom – open to hyporheic zone below. The engineered bottom enhances the stream biology and ecology as well as provides areas of low velocity to allow for fish passage through the culvert.

B.




## TRADITIONAL CULVERT

Evidence suggests that traditional four-sided box culverts (and other traditional culverts) disrupt ecosystem connectivity by a variety of failure mechanisms, such as creating a velocity barrier, outlet perching, and many others. In North America alone, hundreds of thousands of culverts have been installed in fish-bearing streams and threaten river connectivity by creating barriers between fish populations and critical habitat (*Park 2008, Poplar-Jeffers 2009*). Ecological effects of creating artificial stream barriers are well documented, and include: habitat and population fragmentation, reduced genetic diversity, negative water quality, substrate alterations, and decreasing or destruction of fisheries populations (*Poplar-Jeffers 2009, Price 2010, Anderson 2012*).

Contech Engineered Solutions consulted with Colorado State University on the evaluation of Contech's ecological invert technology. The resulting design is an ecological bottom, wherein the culvert bottom will be made up of intermittent slats which allows it to be open to the streambed. These slats and alternating concrete roughness elements (sedimentation members) encourage sedimentation that result in a natural streambed material being deposited and retained in the culvert. Inducing a natural bed through the culvert provides significant environmental and ecological benefits along with inducing fish passage.


*Poplar, Montana*


*Cedar Rapids, Iowa*


*Lewis County, Washington*

# INDUSTRY RESEARCH & COMPREHENSIVE TESTING

The Washington State Department of Fish and Wildlife (WDFW) published a stream-crossing guideline which enumerates nine expected outcomes of a successful stream-simulation culvert design. Hyporheic connectivity differentiates the ecological bottom culvert from traditional culvert options. Of these ten outcomes, nine are expected to be fulfilled by the ecological invert technology, as supported by the results of the testing program (available upon request). The tenth outcome, bed gradation continuity, can be achieved by manual filling of the culvert at installation with natural bed sediments.

| Successful Culvert Design Outcomes | A. i-Series™ Culvert | B. Traditional Culvert w/ Invert (may include buried invert) |
|---|---|---|
| Sizing | ● | ● |
| Flood Conveyance | ● | |
| Fish Passage | ● | |
| Profile Continuity | ● | |
| Hydraulic Diversity | ● | |
| Sediment Transport Continuity | ● | |
| Low Flow Continuity | ● | |
| Margin Habitat | ● | |
| Debris Transport | ● | |
| Connectivity to Subgrade (hyporheic zone) | ● | ● |
| Bed Gradation Continuity | ● (light blue) | |

● This performance summary is based on extensive testing from Colorado State University.

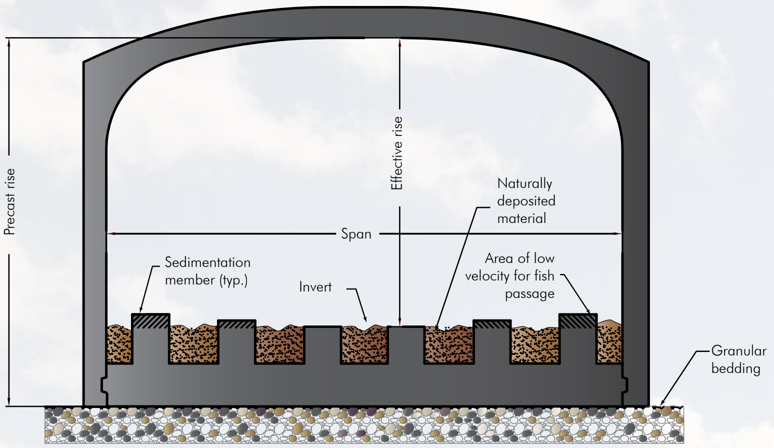
● (light blue) See bed gradation definition to right.

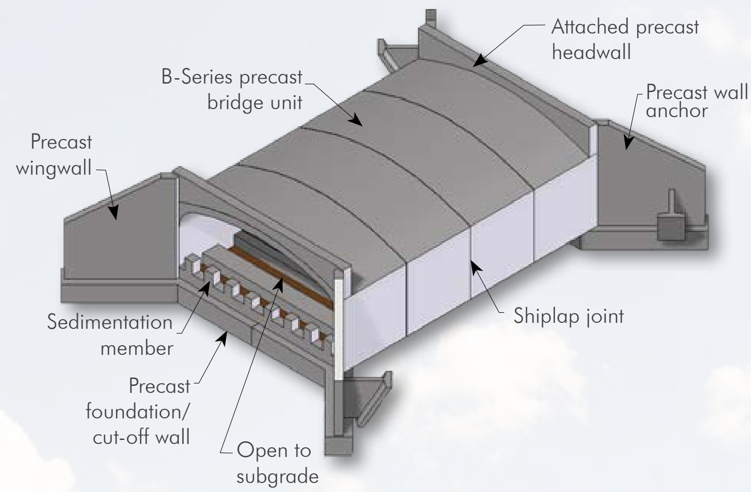
## SUCCESSFUL CULVERT DESIGN OUTCOMES

- **Flood conveyance** is the ability for the culvert to pass the required design flood.
- **Fish passage** is the ability for fish to have appropriate resting areas to allow migration through the culvert
- **Profile continuity** is the preservation of the reachwise stream slope through the culvert. Maintaining slope is achieved by maintaining a natural bed through the culvert which reflects changes in the upstream and downstream reaches, and preventing outlet perching and degradation of the bed inside the culvert.
- **Hydraulic diversity** is the presence of zones of low, zero, or negative (upstream) flow velocities within the culvert along with regions of higher velocities. These zones provide resting habitat for aquatic organisms inside the culvert.
- **Sediment transport continuity** means that bed material transported through the upstream reach is continuously supplied to the culvert bed and supplied by the culvert to the downstream reach at an equivalent rate, allowing the culvert to reflect the bed structure of the stream reach.
- **Low flow continuity** is the maintenance of a channel for fish passage during low-flow events.
- **Margin habitat** is the existence of areas of low velocity and turbulence along and near the banks of a stream where fish, especially juveniles, can use for migration. In the ecological bottom culvert, it is a consequence of developing a low-flow channel in the culvert.
- **Debris transport** is the ability for the culvert to pass large woody debris or miscellaneous detritus.
- The **hyporheic zone** is the region beneath and alongside the streambed where there is interaction between the groundwater and the surface water. The hyporheic zone provides ideal habitat for microbes and invertebrates which are critical to the overall health of the stream.
- **Bed gradation** continuity is the maintenance of a bed material grain size distribution through the culvert which is equivalent to the grain size distribution of bed material upstream and downstream of the culvert. This criteria can be addressed by manual filling of the culvert at installation with natural bed sediments.

# i-SERIES™

## CON/SPAN® CULVERT – SIZE RANGES




| MODEL | SPAN (ft) | EFFECTIVE RISE (ft) | WATERWAY AREA (sf) |
|---|---|---|---|
| i1203 | 12.00 | 3.00 | 30.00 |
| i1204 | 12.00 | 4.00 | 42.00 |
| i1205 | 12.00 | 5.00 | 54.00 |
| i1206 | 12.00 | 6.00 | 66.00 |
| i1207 | 12.00 | 7.00 | 78.00 |
| i1208 | 12.00 | 8.00 | 90.00 |
| i1209 | 12.00 | 9.00 | 102.00 |
| i1210* | 12.00 | 10.00 | 114.00 |
| i1403 | 14.00 | 3.00 | 36.00 |
| i1404 | 14.00 | 4.00 | 50.00 |
| i1405 | 14.00 | 5.00 | 64.00 |
| i1406 | 14.00 | 6.00 | 78.00 |
| i1407 | 14.00 | 7.00 | 92.00 |
| i1408 | 14.00 | 8.00 | 106.00 |
| i1409 | 14.00 | 9.00 | 120.00 |
| i1410* | 14.00 | 10.00 | 134.00 |
| i1603 | 16.00 | 3.00 | 39.00 |
| i1604 | 16.00 | 4.00 | 55.00 |
| i1605 | 16.00 | 5.00 | 71.00 |
| i1606 | 16.00 | 6.00 | 87.00 |
| i1607 | 16.00 | 7.00 | 103.00 |
| i1608 | 16.00 | 8.00 | 119.00 |
| i1609 | 16.00 | 9.00 | 135.00 |
| i1610* | 16.00 | 10.00 | 151.00 |

* Structure rise may vary depending on loading conditions.

| MODEL | SPAN (ft) | EFFECTIVE RISE (ft) | WATERWAY AREA (sf) |
|---|---|---|---|
| i1803 | 18.00 | 3.00 | 42.00 |
| i1804 | 18.00 | 4.00 | 60.00 |
| i1805 | 18.00 | 5.00 | 78.00 |
| i1806 | 18.00 | 6.00 | 96.00 |
| i1807 | 18.00 | 7.00 | 114.00 |
| i1808 | 18.00 | 8.00 | 132.00 |
| i1809 | 18.00 | 9.00 | 150.00 |
| i1810* | 18.00 | 10.00 | 168.00 |
| i2004 | 20.00 | 4.00 | 65.00 |
| i2005 | 20.00 | 5.00 | 85.00 |
| i2006 | 20.00 | 6.00 | 105.00 |
| i2007 | 20.00 | 7.00 | 125.00 |
| i2008 | 20.00 | 8.00 | 145.00 |
| i2009 | 20.00 | 9.00 | 165.00 |
| i2010* | 20.00 | 10.00 | 185.00 |
| i2204 | 22.00 | 4.00 | 68.00 |
| i2205 | 22.00 | 5.00 | 90.00 |
| i2206 | 22.00 | 6.00 | 112.00 |
| i2207 | 22.00 | 7.00 | 134.00 |
| i2208 | 22.00 | 8.00 | 156.00 |
| i2209 | 22.00 | 9.00 | 178.00 |
| i2210* | 22.00 | 10.00 | 200.00 |
| i2404 | 24.00 | 4.00 | 71.00 |
| i2405 | 24.00 | 5.00 | 95.00 |
| i2406 | 24.00 | 6.00 | 119.00 |
| i2407 | 24.00 | 7.00 | 143.00 |
| i2408 | 24.00 | 8.00 | 167.00 |
| i2409 | 24.00 | 9.00 | 191.00 |
| i2410* | 24.00 | 10.00 | 215.00 |

CONTECH® ENGINEERED SOLUTIONS

**Visit us at www.ContechES.com or call Toll Free: 800-338-1122**



i-Series Brochure 2/18 PDF MC