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Date: August 18, 2008
To: Western Wake Partners
From: Ken Bruce, Brown and Caldwell
Subject: Western Wake WRF Site 14 Arch Culvert Options and Preliminary Costs

Currently, Site 14 proposes impacts to four streams for the placement of culverts and fill for four road crossings. Any fill below Ordinary High Water (OHW) in streams is considered an impact to Waters of the U.S. (WOUS). In order to reduce and avoid impacts to these streams, arch culverts can be used to span the streams, therefore, avoiding fill below OHW. Recent discussions with the US Army Corps of Engineers (USACE) and the North Carolina Department of Environmental Quality (DWQ) has unveiled that these agencies do not agree that arch culverts or bottomless box culverts actually avoid impacts to streams. They suggest that these engineering options shade vegetation on stream banks thereby creating instability and erosion of banks, thus impacting the system. If arch culverts were proposed on these crossings and no other impacts to WOUS were proposed on the project, then USACE and DWQ permits would not be required. However, since other impacts are proposed on the project site, it opens these four stream crossings up to review to the agencies since they are included in the Area of Potential Effect. Therefore, further conversations are warranted with these agencies to ensure that proper design and consideration is used when proposing these as a no-impact alternative.

As requested, Brown and Caldwell has researched options to use arch culverts to avoid impacts to streams for the proposed access road on Western Wake Water Reclamation Facility (WRF) Site 14. This information, which is discussed below, can also be used to determine feasibility of using these products to avoid road impacts to streams on all WRF alternative sites. In order to obtain arch culvert options and preliminary costs, the following general assumptions were made:

- Each stream channel is a maximum of 10-foot wide from top of bank to top of bank;
- A 24-foot arch span would be used to ensure no impacts to the stream;
- In-situ soil/rock is adequate to provide foundation support;
- A minimum 10-foot fill is required over arch culverts to ensure that a 64-inch DIP line can be placed on top;
- A 22-foot total fill height is required based on Arcadis design drawings (worst case scenario);
- The roadway shelf width is 70 linear feet with a 2:1 vertical fill slope based on Arcadis design drawings (worst case scenario);
- To reduce costs, aluminum arch culverts will be used; and
- Keystone endwalls will be used to minimize culvert length.

Please note that total installed cost can range from 2 to 4 times material cost depending on in-situ soils, culvert foundation type, and construction methods.

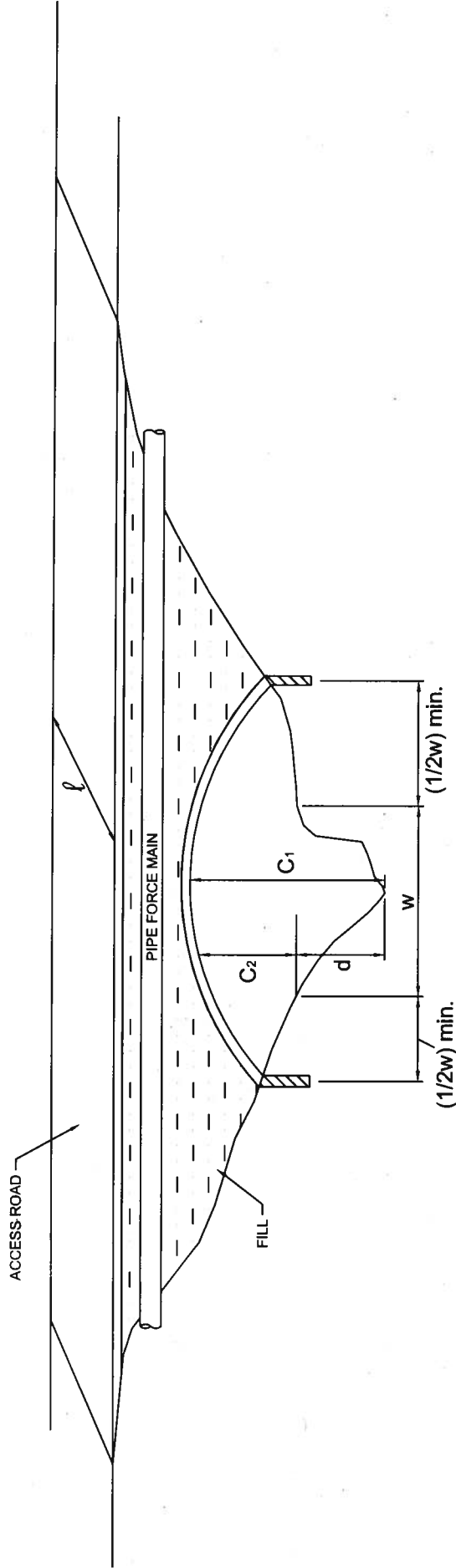
Based on these assumptions, Brown and Caldwell contacted Contech Bridge Solutions, Inc. (Contech) to obtain information and costs for arch culvert options. Contech provided costs and information for two types of culverts: concrete and metal. Concrete spans range from \$1,680 to \$3,050 per linear foot (material only), while metal spans range from \$1,450 to \$2,800 per linear foot (materials only). Based on this information and our assumptions, each crossing on Site 14 would cost approximately \$141,500 for the arch spans and endwalls only. Please see the attached package, which contains Contech's preliminary estimate, general information on arch culverts, and example photographs of arch culvert installation projects.

It is Brown and Caldwell's recommendation that before you move forward with an arch span to avoid impacting WOUS, further conversations are warranted with both the USACE and DWQ to ensure these options will be accepted as not impacting streams.

SD:mc

Attachment

Limitations: This memorandum was prepared solely for Western Wake Partners in accordance with professional standards at the time the services were performed and in accordance with the contract between Town of Cary, lead agency for the Partners and Brown and Caldwell dated June 27, 2008. This document is governed by the specific scope of work authorized by Town of Cary; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Town of Cary and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.



w = Stream width at bank full
 d = depth - bank to thalweg
 l = covered stream length

min. $C_1 = \max.(1.5w, 2d, 0.6l)$

min. $C_2 = \max.(w, d, 0.5l)$

**BROWN AND
CALDWELL**

ACCESS ROAD BRIDGE CROSSING

WESTERN WAKE WWTP EIS

PROJECT NO:
DATE:
SCALE:

ADDENDUM NO:
SHEET REVISED:
ATTACHMENT NO: