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335 S. Main Street, Willits, CA 95490-3977

Reference: 421068

October 6, 2021

William Imhoff
45101 Caspar Point Road
Caspar, CA 95420

Subject: Caspar Point Road Culvert Improvements

Dear William Imhoff:

Below is a summary prepared by SHN of the hydrological assessment and recommendations for improvements of the culvert and stream channel on Caspar Point Road

Existing Conditions

The project site is located on Caspar Point Road just west of Highway 1, south of Jughandle Creek and north of the town of Caspar (see Location Map, Figure 1). Caspar Point Road is a private, gravel road with a relatively flat grade adjoined by private residences and California State Park property on the northwest corner. The existing culvert is five feet in diameter and approximately 40 feet long. The culvert drains an unnamed channel within a 0.6 square mile watershed originating to the east of Highway 1. The channel flows under Highway 1 through a five-foot diameter culvert and then through another five-foot diameter culvert on Caspar Road. The channel at the project site is roughly two feet wide and is entrenched approximate three to four foot deep into the flat, coastal prairie characterized by brush dominated by gorse. Existing conditions of the culvert and adjacent channel are depicted in photos 1-9, all taken on August 3, 2021 (see Photos, Appendix 1).

The culvert at Caspar Point Road is a corrugated metal pipe (CMP) with minimal gravel cover (approximately six inches) over the top of the pipe. The culvert is severely corroded in sections but is set on grade. The site can be characterized as a depositional environment with minimal evidence of channel-related erosion other than small amounts of incision in the channel bed and around the channel inlet and outlet. The channel makes a 78-degree turn to the north as it enters the culvert inlet. A maintained ditch to the west of inlet on the south side of Caspar Point Road starts at the inlet and continues approximately 100 feet to the west.

The channel downstream of the culvert outlet is also approximately two feet wide and slightly less entrenched than the upstream channel. The channel is severely constricted approximately 50 feet downstream of the culvert outlet. This condition persists for roughly another 200 to 300 feet in discrete sections before the channel widens and deepens again as it drains out to the Pacific Ocean.

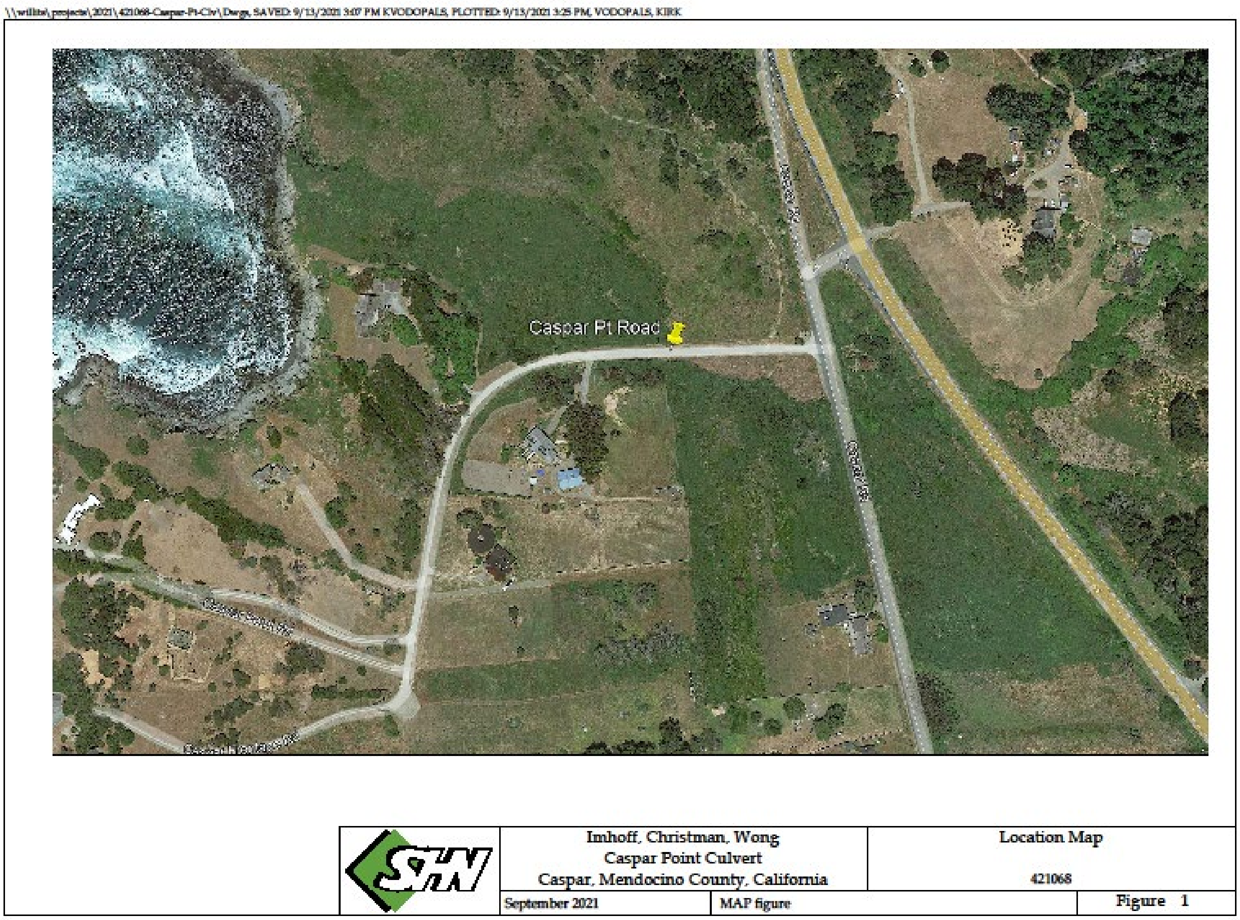


Figure 1 Site Location

Site Hydrology

A Google Earth image of the channel profile extending into the upper watershed indicates that the project location is within a relatively flat region of the watershed (see Figure 2). The project area is situated on a coastal terrace roughly 1,000 feet from the confluence with the Pacific Ocean. This terrace, due to its relatively flat profile, could be considered a depositional region as sediment is transported down from the steeper uphill areas, through the culvert crossings in both Highway 1 and Caspar Road and onto the project area.

Isolated pockets (non-flowing) of surface water were observed at the project area during the low-flow period and during an exceptionally dry year. No spring or artesian water sources were observed in the project vicinity so it is assumed that the observed surface water is groundwater that is not percolating down through the watershed.

A Federal Emergency Management Agency (FEMA) FIRMette was obtained for the project area (see Figure 3). The FEMA map does not provide a Base Flood Elevation for the project area nor are any special flood areas or hazards indicated.

It is assumed that this channel is not a fish-bearing stream due to the small watershed area and steep, rocky ascent out of the Pacific Ocean.

Peak Discharge

An assessment of peak flows was conducted using USGS StreamStats tool (see StreamStats Report, Appendix 2). The mean annual precipitation for the 0.6 square mile watershed was estimated to be 41.4 inches. The 50-year and 100-year return (two and one percent annual exceedance probability) interval flood flows (Q_{50} and Q_{100}) were estimated to be 209 and 247 cubic feet per second (cfs), respectively.

The two-year return interval discharge (50 percent annual exceedance probability) is typically considered the stream-forming flow that dictates the long-term channel shape and design. This two-year discharge is sometimes equated with the bankfull flow that overtops the channel banks and flows out onto the adjacent floodplain. Flood flows have significant periodic impacts during stochastic events and should be accounted for in sizing and armoring the stream crossing, but the channel dimensions upstream and downstream of the culvert are typically calibrated to the bankfull events.

Recommended Culvert Improvements

The peak flow (Q_{100}) estimate of 247 cfs corresponds to a 78-inch diameter culvert using U.S. Department of Transportation Hydraulic Design of Highway Culverts (FHWA 2012). This is a conservative estimate of culvert diameter for a projected (beyond the road fill) culvert with a headwall-to-pipe diameter ratio of 0.9. This headwall-to-pipe diameter ratio was chosen for the lack of large debris within the channel network that would necessitate a larger amount of freeboard within the culvert. A 78-inch culvert diameter has a cross-sectional area opening of roughly 33 ft^2. (See Culvert Nomograph, Appendix 3)

The running surface of Caspar Point Road is relatively shallow compared to the top of the current culvert, so an increase in culvert diameter would be required and thickening of the road surface. Typically, a minimum of six to eight inches of gravel road base should be applied on top of a culvert crossing. A circular culvert with a diameter of 78 inches (6.5 feet) would most likely require elevating the road surface substantially, so a “squash” culvert may be more practical. This type of culvert has an oval cross-section with the height dimension being smaller than the width. It is also a preferred type of culvert for situations where the culvert is located on a bend in the channel as it allows for a wider horizontal opening.

Culvert embedment may also be necessary to create a natural channel bottom to provide for habitat for aquatic species. Special consideration should be given to the culvert material due to the coastal saltwater influence. A metal culvert is required for structural purposes, but an additional lining or coating should be specified to mitigate against the corrosive saltwater environment.

A multi-plate pipe arch manufactured by CONTECH with a 7-foot 11-inch span (width) and 5-foot 7-inch rise has an area opening of 36 square feet. This culvert could be embedded to allow for a natural stream bottom but would require raising the existing road surface up approximately 1.5 feet (see Pipe Arch Diagram, Appendix 4). Other crossing options that would achieve a natural channel bottom and minimal changes in the road elevation would be a concrete box culvert, aluminum box culvert, or a low-profile bottomless culvert set on concrete footings. The concrete and aluminum box culverts would need to be oversized to allow for embedment.

The new crossing should be installed at an appropriate angle to allow for an easy transition of the channel flow into the crossing inlet. This is most likely around a 30-degree skew angle from the current perpendicular alignment.

Other site improvements associated with a new crossing would include inlet and outlet armoring either with rock or concrete headwalls. A concrete headwall would provide maximum potential road and shoulder width as it can be set vertically against the road prism. Rock armoring would require an angled placement and would either encroach into the channel or reduce the road prism width. Other optional improvements would be to add a critical dip and/or ditch relief culvert downstream of the existing culvert to improve drainage during peak flows.

It should be noted that all improvement recommendations are based on visual observations and existing hydrologic data. No topographical survey data (including property boundaries) was available for this assessment.

References

Federal Highways Administration 2012. Schall, J.D., Thompson, S.M. Zerges, R.T. Kilgore, and J.L. Morris. 2012. Hydraulic design of highway culverts: third edition. U.S. Department of Transportation, Federal Highway Administration. HDS-5. Publication Number HIF-12-026 https://www.fhwa.dot.gov/engineering/hydraulics/pubs/12026/hif12026.pdf

United States Geological Survey. (May 2019). *StreamStats*. Accessed May 2019 at: https://streamstats.usgs.gov/ss/

Please call me at (707) 459-4518 if you have any questions.

Sincerely,

SHN

[signature]

Jason Island, PE 64809
Senior Civil Engineer

JGI:alh

Appendices:
1. Photos
2. StreamStats Report
3. Culvert Nomograph
4. Pipe Arch Diagram

Photos 1

Photo 1. Downstream of culvert facing upstream

Photo 2. Channel immediately downstream of culvert outlet

Photo 3. Culvert inlet facing downstream

Photo 4. Culvert inlet standing on the west side

Photo 5. Caspar Road culvert outlet facing upstream

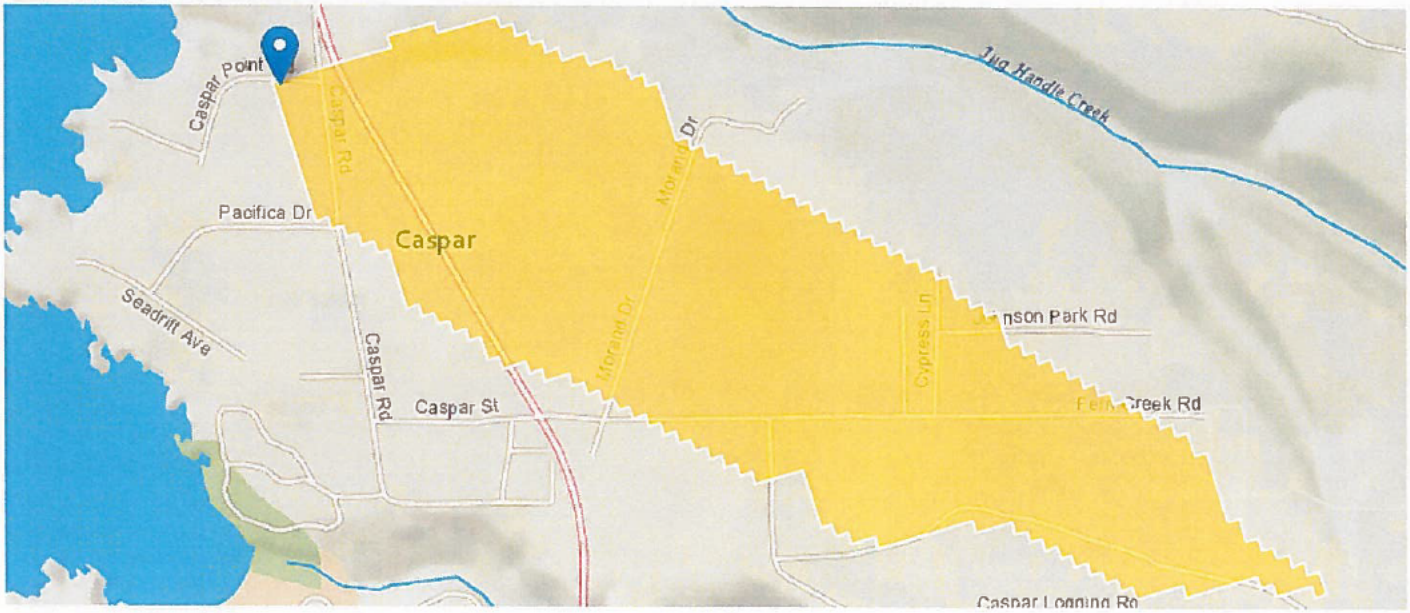
Photo 6. Downstream channel below culvert outlet

Photo 7. Downstream channel approximately 50 feet below outlet

Photo 8. Downstream channel facing upstream

StreamStats Report 2

Region ID: CA
Workspace ID: CA20210727164912636000
Clicked Point (Latitude, Longitude): 39.37236, -123.81710
Time: 2021-07-27 09:49:30 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.6	square miles
PRECIP	Mean Annual Precipitation	41.4	inches
ELEV	Mean Basin Elevation	200	feet
ELEVMAX	Maximum basin elevation	332	feet
FOREST	Percentage of area covered by forest	31.3	percent
BSLDEM30M	Mean basin slope computed from 30 m DEM	3.85	percent
MINBELEV	Minimum basin elevation	45	feet
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88	45	feet

Peak-Flow Statistics Parameters [2012 5113 Region 1 North Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.6	square miles	0.04	3200
PRECIP	Mean Annual Precipitation	41.4	inches	20	125

Peak-Flow Statistics Flow Report [2012 5113 Region 1 North Coast]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp

SHN	Imhoff, Christman, Wong Caspar Point Culvert Caspar, Mendocino County, California	StreamStats Report Page 1 421068
	September 2021 / MAP figure	Figure 2a

50-percent AEP flood	44.6	ft^3/s	18.1	110	58.6
20-percent AEP flood	91.3	ft^3/s	43.1	193	47.4
10-percent AEP flood	126	ft^3/s	61.7	257	44.2
4-percent AEP flood	172	ft^3/s	86.8	341	42.7
2-percent AEP flood	209	ft^3/s	105	415	42.7
1-percent AEP flood	247	ft^3/s	121	503	44.3
0.5-percent AEP flood	283	ft^3/s	138	579	44.4
0.2-percent AEP flood	333	ft^3/s	159	698	46

Peak-Flow Statistics Citations

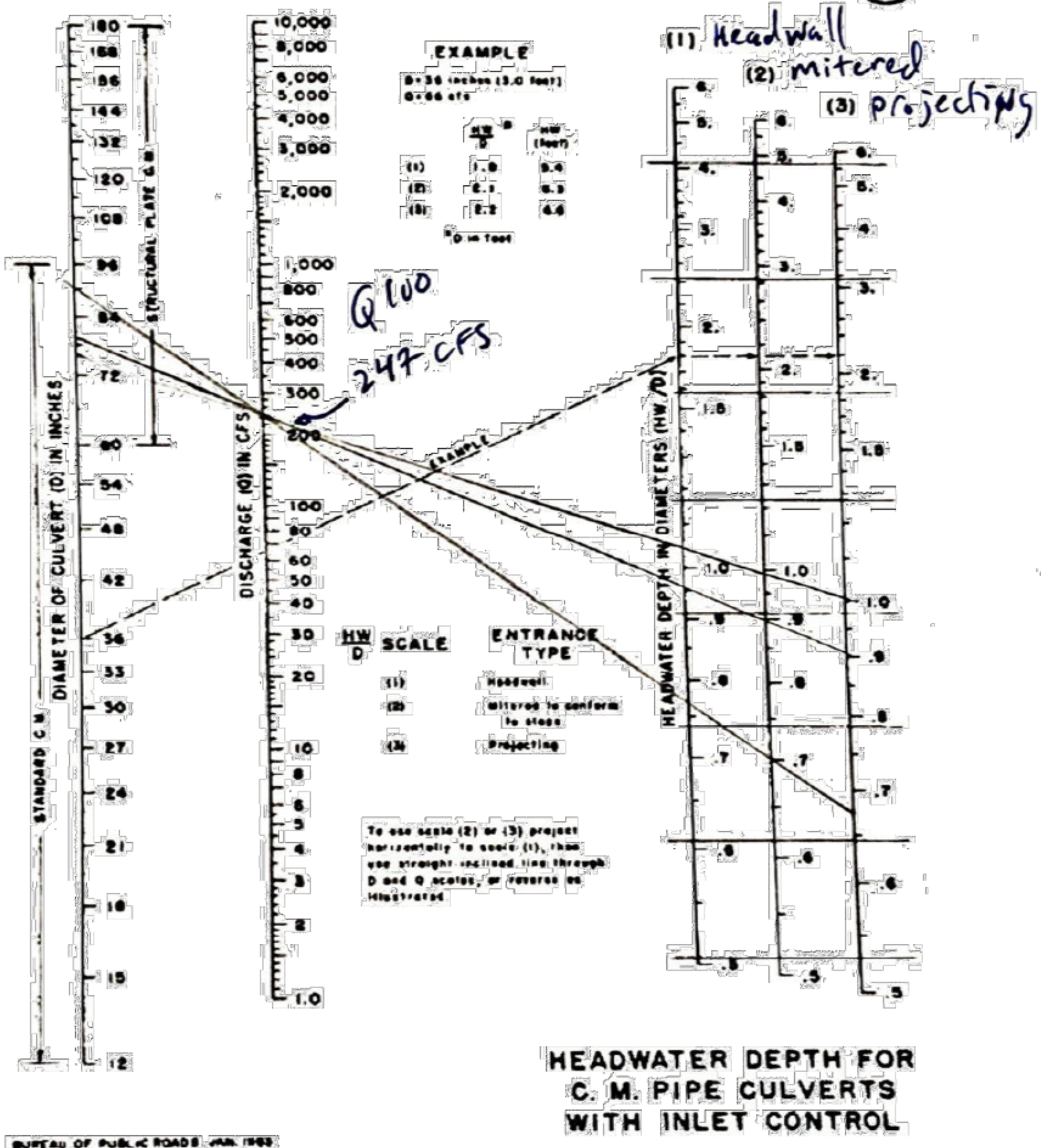
Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles,2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl. (http://pubs.usgs.gov/sir/2012/5113/)

Application Version: 4.6.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

Culvert Nomograph 3

HW/D	Pipe Dia (in)
0.9	78
0.67	90

CHART 2B



SHN	Imhoff, Christman, Wong Caspar Point Culvert Caspar, Mendocino County, California	Culvert Nomograph 421068
	September 2021 / MAP figure	Figure 3

Pipe Arch Diagram 4

84 PI

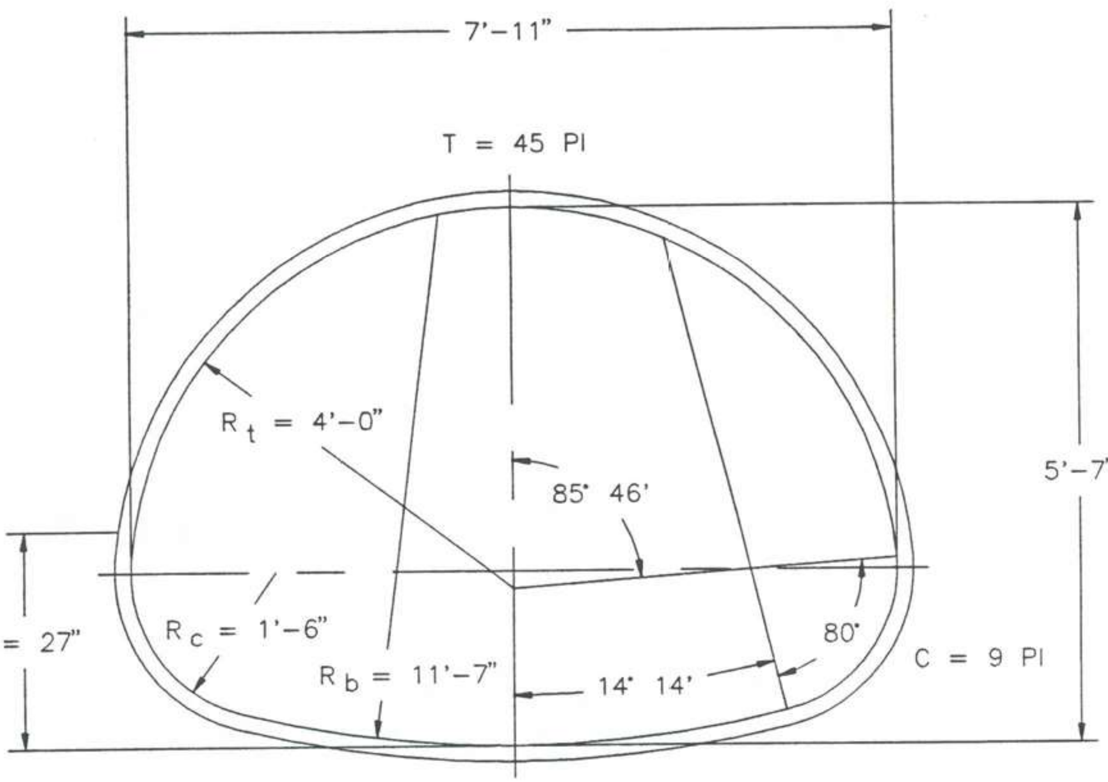


PLATE MAKE–UP:

TOP PL's: 1 @ 21, 1 @ 24 PI
CORNER PL's: 1 @ 9 PI
BOTTOM PL's: 1 @ 21 PI

TOTAL PL's: 2 @ 9, 2 @ 21, 1 @ 24 PI

SCALE: 1/2" = 1'–0"

AREA = 36 SQ. FT.

NOTES:
1. ALL DIMENSIONS ARE TO THE INSIDE CORRUGATION CRESTS, UNLESS OTHERWISE NOTED.
2. DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.
3. "B" DIMENSION IS MEASURED TO TOP OF CORNER PLATES.

CONTECH®
CONSTRUCTION PRODUCTS INC.

MULTI–PLATE
PIPE–ARCH
7'–11" x 5'–7"

Drawing Date:	Revision Date:	Drawing Number:
T.R.T. 12–8–94		1009442A