

# **SECTION C**

CULVERTS



## HAER CULVERTS OVERVIEW

The 12 individual chapters presented in this section have been adapted with specific information for each particular HAER-identified culvert, with relevant cultural, historical, and technical information, as well as detailed treatment recommendations for each historic culvert.

Culvert inventory sheets contain the following information:

- Photographs and maps,
- Location information,
- Documentation of existing conditions,
- Structural conditions, such as load rating and overall condition,
- Pertinent considerations adjacent to culvert locations, such as private property, utilities, and signage,
- Archaeological sites identified within vicinity of the culvert,
- Statement of historic/cultural significance and historic references, and
- Character-defining features of each culvert.

Detailed written pages also address:

- References to current civil, electrical, and structural conditions, and identified issues,
- Historic and cultural site context pertinent to each historic culvert location, and
- Site-specific recommendations by the team tailored to the individual conditions at each culvert.

Lastly, current drawings indicate existing conditions and present conceptual treatment recommendations with preferred railing type for each culvert. Historic drawings are not available for individual culverts.





# Culvert Matrix

## Hana Highway, Route 360

	Bridge Name	Mile Point	Details	Length (ft)	Year Reconstructed	Structure Type	No. Spans	Latitude	Longitude
1C	Culvert	6.57	24" RCP						
2C	Culvert #1	7.03	8' x 9.5' Box	9		Concrete Slab	1	20d 52m 56s	156d 12m 08s
3C	Culvert	9.13	24" RCP						
4C	Kolea Culvert	9.24	5' x 10' Box						
5C	Culvert	10.18	8' x 8' Box						
6C	Culvert	10.48	3' x 3' Box						
7C	Culvert	11.82	24" RCP						
8C	Culvert	12.12	2' x 1' Rock Box						
9C	Culvert	12.65	24" RCP						
10C	Culvert	14.63	8' x 4" Box						
11C	Culvert	14.91	? Filled. As-built: 48" SSP & 4' x 4' Box						
12C	Culvert	15.4	24" RCP						
13C	Culvert	16.06	12' x 5' Box						
14C	Culvert	17.03	24" RCP						
15C	Culvert	17.19	24" RCP						
16C	Culvert	17.27	(3) 42" RCP & (1) 24" RCP						
17C	Culvert	17.31	36" RCP & 24" RCP						
18C	Culvert	17.36	? Size. 24" RCP?						
19C	Culvert #2 (Bridge)	17.46	Clr Ht: 6' (u/s) & 13' (d/s) and Clr Wth: 7' (u/s) & 10' (d/s)	10	circa 1937-1940	Concrete Slab	1	20d 51m 04s	156d 08m 33s
20C	Culvert #3 (Bridge)	17.48	Clr Ht: 4' (u/s) & 8' (d/s) and Clr Wth: 10' (u/s) & 14' (d/s)	15	circa 1937-1940	Concrete Slab	1	20d 51m 04s	156d 08m 31s
21C	Culvert #4 (Bridge)	17.49	Clr Ht: 7' (u/s) & 10'-6" (d/s) and Clr Wth: 8' (u/s) & 11' (d/s)	13	circa 1937-1940	Concrete Slab	1	20d 51m 03s	156d 08m 31s
22C	Culvert	17.51	Clr Ht: 5'-4" (u/s) & 9'-2" (d/s) and Clr Wth: 11'-9"						
23C	Culvert	17.55	24" RCP						
24C	Culvert	17.65	24" RCP						
25C	Waiokamilo Culvert	18.08	Clr Ht: 6' and Clr Wth: 13'-8"	24		Concrete Slab	1	20d 50m 55s	156d 08m 10s
26C	Culvert	20.01	30" CMP						
27C	Culvert	20.03	36" CMP						
28C	Culvert	20.05	48" CMP						
29C	Culvert	21	6' x 8' Box						
30C	Culvert	21.11	9' x 8' Box						



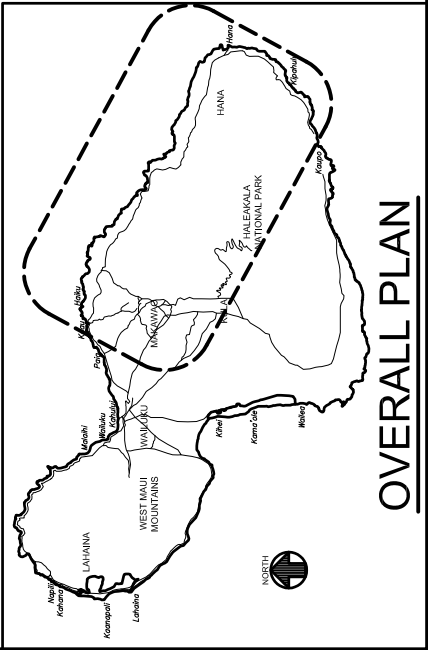
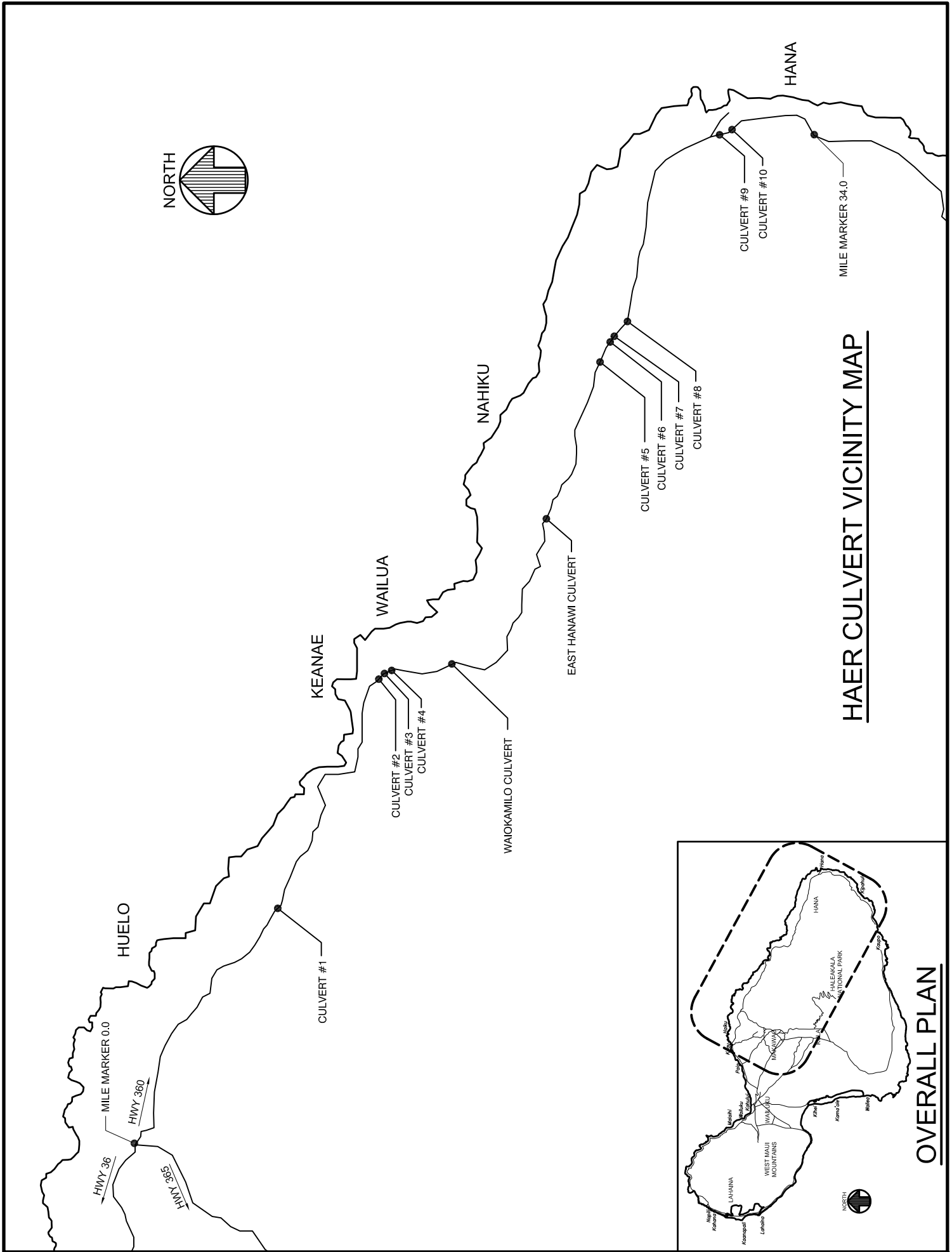
# Culvert Matrix

## Hana Highway, Route 360

	Bridge Name	Mile Point	Details	Length (ft)	Year Reconstructed	Structure Type	No. Spans	Latitude	Longitude
31C	Culvert	21.29	18" RCP (inlet) & 2' x 1' Rock (outlet)						
32C	Culvert	21.92	(2) 24" RCP						
33C	Culvert	22.1	4' x 4' Box						
34C	Culvert	22.52	4' x 4' Rock Box						
35C	Culvert	22.54	18" RCP						
36C	Culvert	22.79	3' x 8' Box						
37C	Culvert	22.9	24" RCP						
38C	Culvert	23.04	48" CMP						
39C	Culvert	23.21	6' x 4' Box						
40C	Culvert	23.26	6' x 8' Box						
41C	Culvert	23.7	48" RCP						
42C	East Hanawi Culvert	24.2	Int. Ht: 7'-6" & Int. Wth: 12'-0"	11'-8"		Concrete Slab	1	20d 48m 36s	156d 06m 26s
43C	Culvert	24.38	24" RCP						
44C	Culvert	24.71	2' x 2' Rock Box						
45C	Culvert	24.9	3' x 3' Box						
46C	Culvert	26.13	4' x 4' Box						
47C	Culvert	26.33	2' x 1' Rock Box						
48C	Culvert	27.26	3' x 7' Box						
49C	Culvert	27.41	24" CMP						
50C	Culvert	27.6	2.5' x 2.5' Rock Box						
51C	Culvert	27.7	1' x 2.5' Rock Box						
52C	Culvert #5	29.78	Clr Ht: 10'-6" and Clr Wth: 14'-6"	18		Concrete Slab	1	20d 47m 16s	156d 02m 17s
53C	Culvert #6	30.02	Clr Ht: 7' and Clr Wth: 11'-7"	12		Concrete Slab	1	20d 47m 13s	156d 02m 06s
54C	Culvert #7	30.13	Clr Ht: 5'-6" and Clr Wth: 5'-4"	6		Concrete Slab	1	20d 47m 11s	156d 02m 00s
55C	Culvert #8	30.44	Clr Ht: 8'-8" and Clr Wth: 11'-6"	13		Concrete Slab	1	20d 47m 02s	156d 01m 47s
56C	Culvert #9	33.65	Clr width: 14'-0" and Length: 14'-1" (original) / Clr width: 14'-0" to 23'-0" and Length: 13'-11" (widen)	15		Concrete Slab	1	20d 45m 44s	155d 59m 38s
57C	Culvert #10	34	12.5' x 17' Box	14		Concrete Slab	1	20d 45m 38s	155d 59m 33s

HAER Culverts







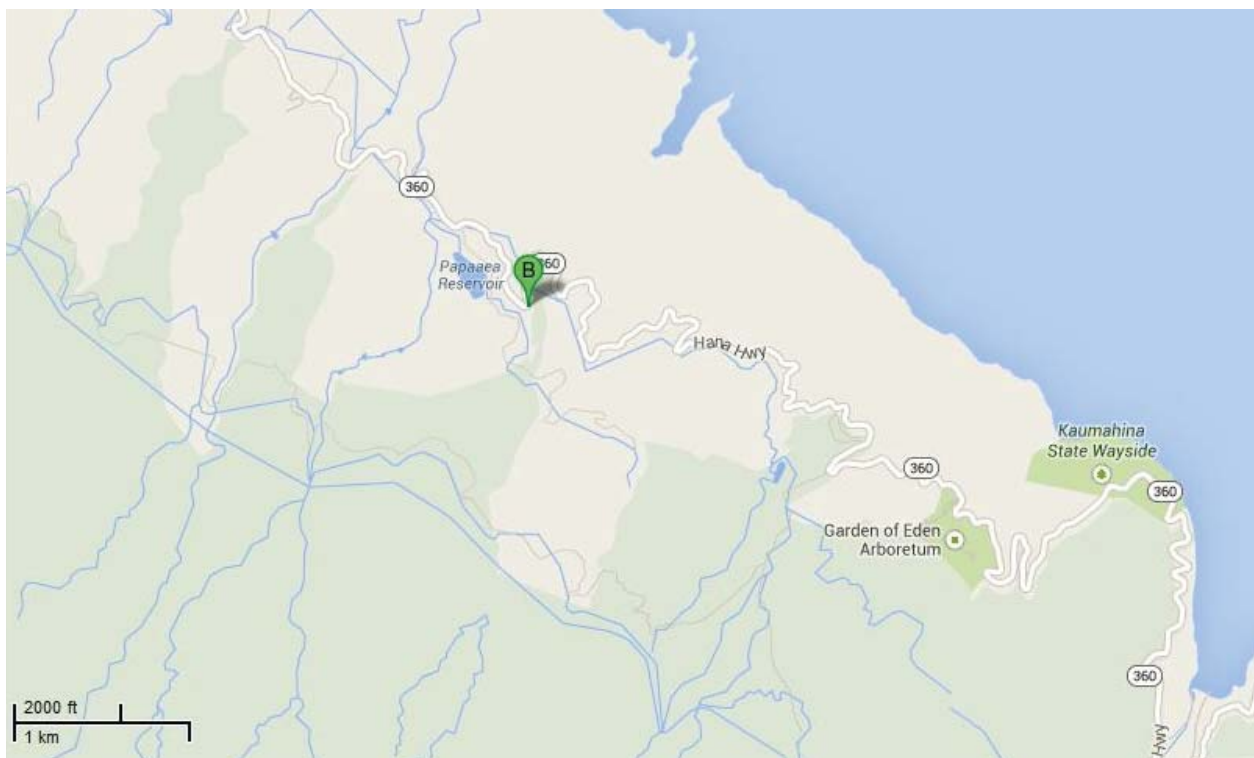
Culvert #1

2C





Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 52m 56s
<b>Longitude</b>	156d 12m 08s
<b>Mile Point</b>	7.03

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 19.75 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	8.00 feet
<b>Clear Height</b>	10 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 17.75 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Solid Parapets
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 24 inches</li><li>• Downstream Railing Height = 24 inches</li></ul>
<b>Parapet Profile</b>	<ul style="list-style-type: none"><li>• No Cap</li><li>• Flat Parapet</li></ul>
<b>Parapet Inscription</b>	None

# CULVERT INFORMATION

## Culvert Features

Culvert #1 is located at mile point 7.03 and has a clear opening of approximately 8.00 feet wide by 10 feet high. The culvert is 17.75 feet long. The top slab is concrete with CRM abutment walls, and the bottom is an unlined channel.



*Setting of Culvert #1  
Courtesy of FAI*



*Kahului approach to Culvert #1 toward Hana  
Courtesy of NOEI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	West Makaiwa
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Solid Parapets</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>

# CULVERT INFORMATION

## Significance & Context

### ***Archaeological / Cultural Significance***

Culvert #1 is located within West Makaiwa Ahupuaa.<sup>1,2</sup> The Hawaiian word *makaiwa* translates as, “Mother-of-pearl eyes, as in an image, especially of the god Lono.”<sup>3</sup> No other specific cultural or archaeological information could be found for this particular location.

Refer to Section G, Appendix 1, Figure 8 for nearby archaeological study areas.<sup>4</sup>

### ***Adjacent Cultural Sites***

No documented archaeological sites are located within 200 meters of Culvert #1.

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1 U.S. Geological Survey, ed., *Haiku Quadrangle, Hawaii*, 7.5 Minute Series (United States Department of the Interior, 1992).

2 Joseph Iao, “Portion of Hamakualoa & Koolau Maui,” registered map no. 2482, Hawaii Territory Survey (1909).

3 Mary Kawena Pukui and Samuel H. Elbert, *Hawaiian Dictionary: Hawaiian-English, English-Hawaiian*, rev. and enl. ed. (Honolulu: University of Hawaii Press, 1986).

4 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	<ul style="list-style-type: none"><li>• Signs are in good condition</li><li>• Missing Object Marker Type 3 - Left Eastbound</li></ul>
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic.

This culvert receives its runoff from an 88-acre (approximate) drainage area and has a terrain that consists of mostly forest type. The upstream and downstream ends of the culvert are highly vegetated and overgrown. The absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Culvert #1 is a one-lane reinforced concrete slab culvert. Metal guardrails with end treatments are located at the upstream Kahului and downstream Hana approaches. There is a CRM wall at the upstream Hana approach and no approach wall at the downstream Kahului approach. The upstream and downstream concrete parapets have a height of 24 inches. Neither parapet has been crash-tested for a TL-2.

The current curb-to-curb dimension is 17.75 feet, which for a one-lane culvert is adequate for this project's design criteria of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).



# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #1 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #1 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the new railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum. Thickness of the fill on the culvert, between the deck and the asphaltic concrete overlay, shall be limited as shown on the following drawings so as to not affect the height of the new crash-tested railings (refer to "Railings/Parapets" section for more information). As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.



# RECOMMENDATIONS

## **CRM Approach Walls**

The existing CRM walls at the approaches to the culvert do not meet the TL-2 crash requirements and cannot act as the culvert's traffic features. The existing CRM approach walls are recommended to be replaced with a reinforced concrete wall with a new natural rock façade. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). To eliminate the potential of a blunt end collision occurring, it is recommended to install guardrails and an end treatment at the approach corners to the culvert after the stone masonry guardwall.



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges:



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

#19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## **Railings / Parapets**

The concrete culvert parapets do not meet TL-2 crash requirements. It is recommended to replace the parapets on the upstream and downstream sides with a similarly designed reinforced concrete parapet. For this purpose, it is recommended to use a vertical concrete barrier rail concrete parapet which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to "Deck" section). Also, drainage should be provided through the base of each parapet.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable. Also, new concrete railing heights, as measured from the deck, shall not be less than existing railings. As a design consideration, future

# RECOMMENDATIONS

design team shall consult with FHWA, HDOT, and SHPD whether the FHWA approved concrete crash-tested railing design height can be changed to match existing conditions and have a straight exterior surface.

## ***Foundations, Wingwalls, & Abutments***

The CRM culvert walls and wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current condition of the foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. If it is determined necessary to rehabilitate the concrete foundations, it is recommended they be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support 10-tons at a minimum, per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

### West Bridge Approach

- Add Object Marker Type 3 - Right (OM3-R) to East Bound

### East Bridge Approach

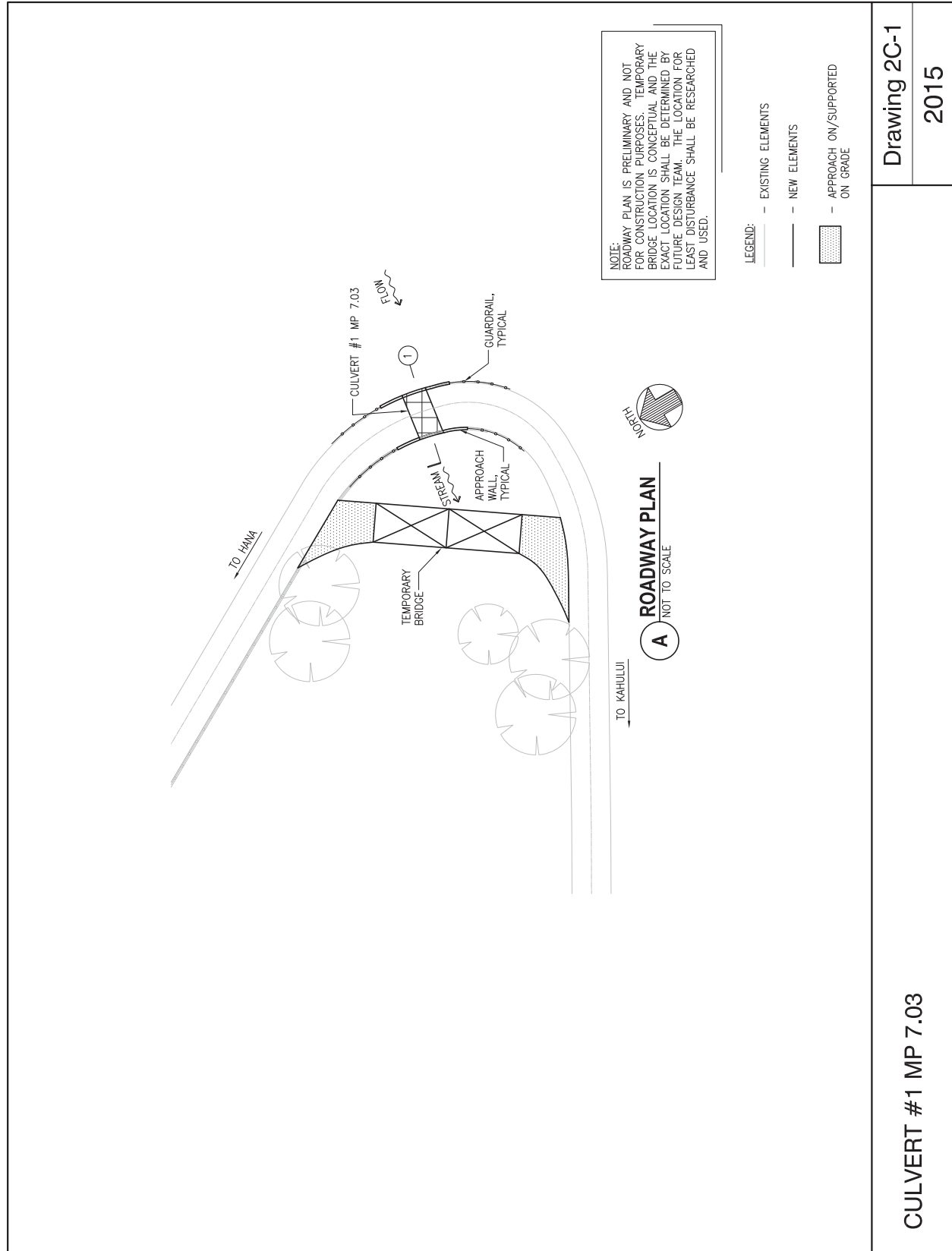
- Add Yield sign (R1-2) and “To On Coming Traffic” plaque (R1-2a)
- Add Yield Line

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

# RECOMMENDATIONS

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #1 at this time.





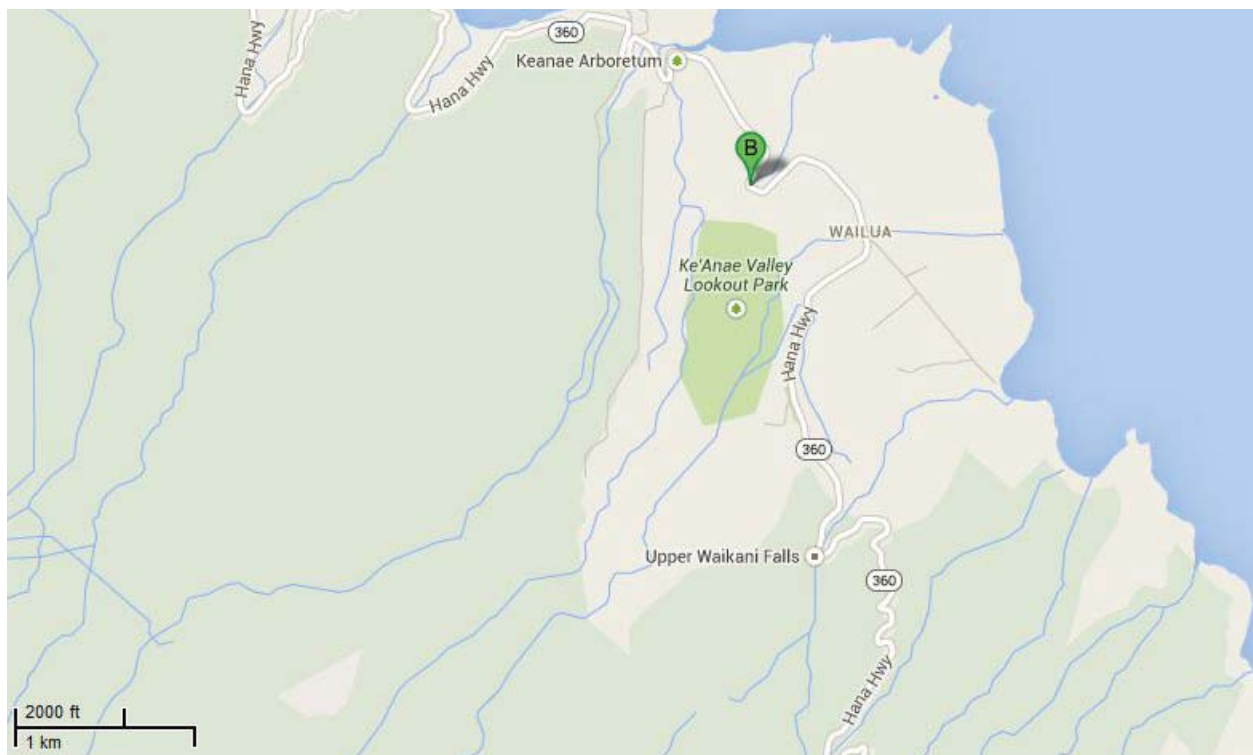
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Culvert #2 19C





Culvert Number					Island	Maui
Date of Construction	circa 1937-1940				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 51m 04s
<b>Longitude</b>	156d 08m 33s
<b>Mile Point</b>	17.46

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 23.00 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	15.00 feet
<b>Clear Height</b>	6 feet (upstream) & 13 feet (downstream) (approx)
<b>Deck Width</b>	Curb-to-Curb = 20.75 feet
<b>Abutment Material</b>	• CRM (upstream) & Concrete (downstream) Walls
<b>Wingwall Material</b>	• CRM Wingwalls
<b>Floor / Decking Material</b>	• Reinforced Concrete Top Slab • Unlined Bottom
<b>Parapet / Railing Type</b>	CRM (upstream) & Concrete Solid (downstream) Parapets
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	• Upstream Railing Height = 24 inches • Downstream Railing Height = 27 inches
<b>Parapet Profile</b>	• No Cap • Flat Parapet with Board-Formed Concrete Texture
<b>Parapet Inscription</b>	None

# CULVERT INFORMATION

## Culvert Features

Culvert #2 is located at mile point 17.46 and has a clear opening of approximately 15.00 feet wide by 6 feet high at the upstream end and 13 feet high at the downstream end. The culvert is approximately 23.00 feet long. According to the HAER report, the original date of construction is unknown, but the culvert was widened on the downstream side circa 1937-1940.<sup>1</sup> The top slab and walls are concrete with CRM and concrete abutment walls, and the bottom is an unlined channel.



*Setting of Culvert #2  
Courtesy of NOEI*



*Kahului approach to Culvert #2 toward Hana  
Courtesy of NOEI*

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<sup>1</sup> "Hana Belt Road," Historic American Engineering Record, HAER HI-75 (2005).

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Waianu
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	Circa 1937-1940
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	<ul style="list-style-type: none"> <li>• Walker Site 94, the Heiau of Ohia, was once located approximately 115 meters southeast of historic Culvert #4. The <i>heiau</i> was documented by Walker as, "Stones removed to build pig pen, and outlines thus lost. Probably an agricultural <i>heiau</i> built by a chief named Kaimuki."</li> </ul>
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> <li>• Taro farm located on downstream side</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM (upstream) &amp; Concrete (downstream) Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• CRM (upstream) &amp; Concrete Solid with Board-Formed Texture (downstream) Parapets</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>



# CULVERT INFORMATION

## Significance & Context

### Archaeological / Cultural Significance

Culvert #2 is located at the Ohia Stream crossing of Hana Highway, Route 360, within Waianu Ahupuaa. The Hawaiian word *ohia* is most commonly used to refer to a type of tree (*Metrosideros macropus*), but may also be used for a tomato, a native variety of sugar cane, a variety of taro, a red birthmark, and for the word “tabooed.”<sup>2</sup>

The Keanae region is described as a unique wet-taro growing area developed by the early inhabitants for irrigated taro with a *loi* complex that covered the peninsula. The Native Hawaiian mythology states that the god Kane accompanied by Kanaloa, thrust his *kauila* staff into solid rock and water gushed forth. Additionally, Ashdown stated that the Lualailua fishponds were located at Keanae, and that they were considered sacred, or *wahi pana*.

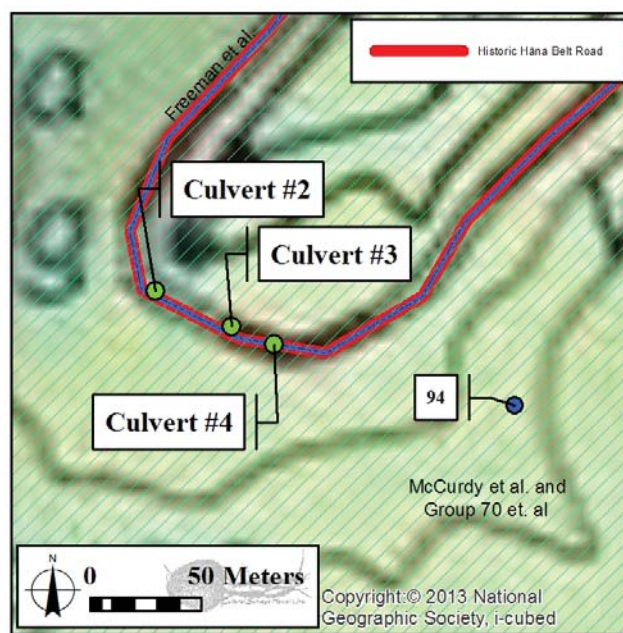
The initial occupation of this portion of Maui first occurred along the coastal region about A. D. 1200. The accepted pre-contact settlement pattern for the region of Keanae/Wailuanui centers on the series of occupational episodes that utilized the Palauhulu Stream for taro (*Colocasia esculenta*) cultivation.

Refer to Section G, Appendix 1, Section 3.1.2.5 for the regional history of Keanae, and to Section G, Appendix 1, Figure 10 for nearby archaeological study areas.<sup>3, 4, 5</sup>

### Adjacent Cultural Sites

Walker Site 94, the Heiau of Ohia, was once located approximately 170 meters southeast of historic Culvert #2. The *heiau* was documented by Walker as,

“Stones removed to build pig pen, and outlines thus lost. Probably an agricultural *heiau* built by a chief named Kaimuki.”<sup>6</sup> Walker was not able to relocate the site, and Soehren was unable to identify the site during his 1963 survey as well.<sup>7</sup> Refer to Section G, Appendix 1, Table 1: Heiau sites identified by Walker (1931) along the historic portion of Hana Highway, and to the adjacent figure for approximate location of previous *heiau* relative to Culvert #2.



2 Mary Kawena Pukui and Samuel H. Elbert, *Hawaiian Dictionary: Hawaiian-English, English-Hawaiian*, rev. and enl. ed. (Honolulu: University of Hawaii Press, 1986).

3 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākuāloa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

4 Group 70 International, Inc., Davianna McGregor, Ph.D., and Cultural Surveys Hawaii, Inc., “Kalo Kanu o ka ‘Aina, A Cultural Landscape Study of Ke’anae and Wailuanui, Ko’olau District, Island of Maui,” prepared for the County of Maui Planning Department (1995).

5 Todd D. McCurdy, Tanya L. Lee-Greig, and Hallett H. Hammatt, “Literature Review and Field Inspection for the Proposed Hana Highway Improvements Huelo to Hāna, Phase II Project, Makaīwa to Ko’olau Ahupua’a, Hāna District, Maui Island TMK: [2] 1-1-001:999; [2] 1-1-002:999; [2] 1-1-007:999; [2] 1-1-008:999; [2] 1-1-009:999 and [2] 1-2-001:999 (pors),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2014).

6 Winslow Walker, *Archaeology of Maui*, 1931, manuscripts on file, Bishop Museum Archives, Honolulu.

7 Lloyd J. Soehren, *An Archaeological Survey of Portions of East Maui, Hawai’i*, Bernice Pauahi Bishop Museum (Honolulu: 1963).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	Two Lanes
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	<ul style="list-style-type: none"><li>• Signs are in good condition</li><li>• Missing Object Marker Type 3 - Left Eastbound</li></ul>
<b>Apron</b>	None
<b>Civil Utilities</b>	<ul style="list-style-type: none"><li>• Water: Existing waterline, upstream side</li></ul>
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

The invert of the culvert is approximately 13 feet below the roadway pavement. There is a 6-inch waterline that runs along the upstream end of the culvert.

The roadway above the culvert is striped for two lanes, allowing vehicles to travel across the span of the culvert without yielding to oncoming traffic.

Culvert #2 receives storm water runoff from a 51-acre drainage area (approximate) and consists of mostly forest type terrain. The downstream end of the culvert consists of an unnamed shallow stream that travels towards the ocean and has a constant flow caused by a continuous flowing natural spring. The absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Culvert #2 is a two-lane reinforced concrete slab culvert. CRM walls are located at each corner of the approaches to the culvert. The upstream CRM parapet and downstream concrete parapet have a height of 24 inches and 27 inches, respectively. Neither parapet has been crash-tested for a TL-2.

The current curb-to-curb dimension is 20.75 feet, which for a two-lane culvert does not meet the design criteria minimum of 24 feet.

Load rating for this culvert is unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #2 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #2 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question. Near the base of Culvert #2, Ohia Stream provides irrigation for agricultural fields located downstream of Hana Highway, Route 360. If Culvert #2 is to be rehabilitated, care shall be taken to ensure that construction activities do not interfere or contaminate the stream.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

There are no record drawings for this culvert. It is recommended to widen the deck on the downstream side, scan the deck for reinforcing, and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the new railings and a 40-ton load carrying capacity. The widened deck slab shall be designed to cantilever off the existing slab and abutments. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum. Thickness of the fill on the culvert, between the deck and the asphaltic concrete overlay, shall be limited as shown on the following drawings so as to not affect the height of the new crash-tested railings (refer to "Railings/Parapets" section for more information). As a design consideration,



# RECOMMENDATIONS

suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

## **CRM Approach Walls**

The existing CRM walls at the approaches to the culvert do not meet the TL-2 crash requirements and cannot act as the culvert's traffic features. The existing CRM approach walls are recommended to be replaced with a reinforced concrete wall with a new natural rock façade. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The upstream Kahului and upstream and downstream Hana approach corners have adequate room to curve the approach walls away from the roadway so as to eliminate the potential of a blunt end collision occurring. The downstream Kahului approach corner does not have adequate room for this; therefore, it is recommended to install guardrails and an end treatment at this corner after the stone masonry guardwall.

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## **Railings / Parapets**

The culvert parapets currently do not meet TL-2 crash requirements. The upstream CRM parapet is recommended to be replaced with a reinforced concrete wall with a new natural rock façade. Since the approach walls are similar to the upstream parapet, it is recommended to construct the upstream parapet monolithic with the approach walls. Therefore, the upstream parapet will be replaced with a stone masonry guardwall (refer to Section G, Appendix



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

# RECOMMENDATIONS

5. *Proposed Crash-Tested Railing Options*). The downstream parapet will be replaced with a similarly designed reinforced concrete parapet, such as the vertical concrete barrier rail (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the existing deck is recommended to determine whether it can support the design loads of the parapets (refer to “Deck” section). Also, drainage should be provided through the base of each parapet.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable. Also, new concrete railing heights, as measured from the deck, shall not be less than existing railings. As a design consideration, future design team shall consult with FHWA, HDOT, and SHPD whether the FHWA approved concrete crash-tested railing design height can be changed to match existing conditions and have a straight exterior surface.

## ***Foundations, Wingwalls, & Abutments***

The CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current material composition of the CRM/concrete abutments and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The concrete portions of the culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert’s lifespan. If it is determined necessary to rehabilitate the CRM and concrete abutments, and foundations they are recommended to be replaced in-kind.

If it is determined necessary to rehabilitate the CRM/concrete abutments, it is recommended that the concrete portions be replaced in-kind and CRM portions be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed CRM façade portions shall closely match that of the original historic craftsmanship along Hana Highway.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

# RECOMMENDATIONS

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver's visibility should be trimmed or removed per an approved landscape plan. Signage shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

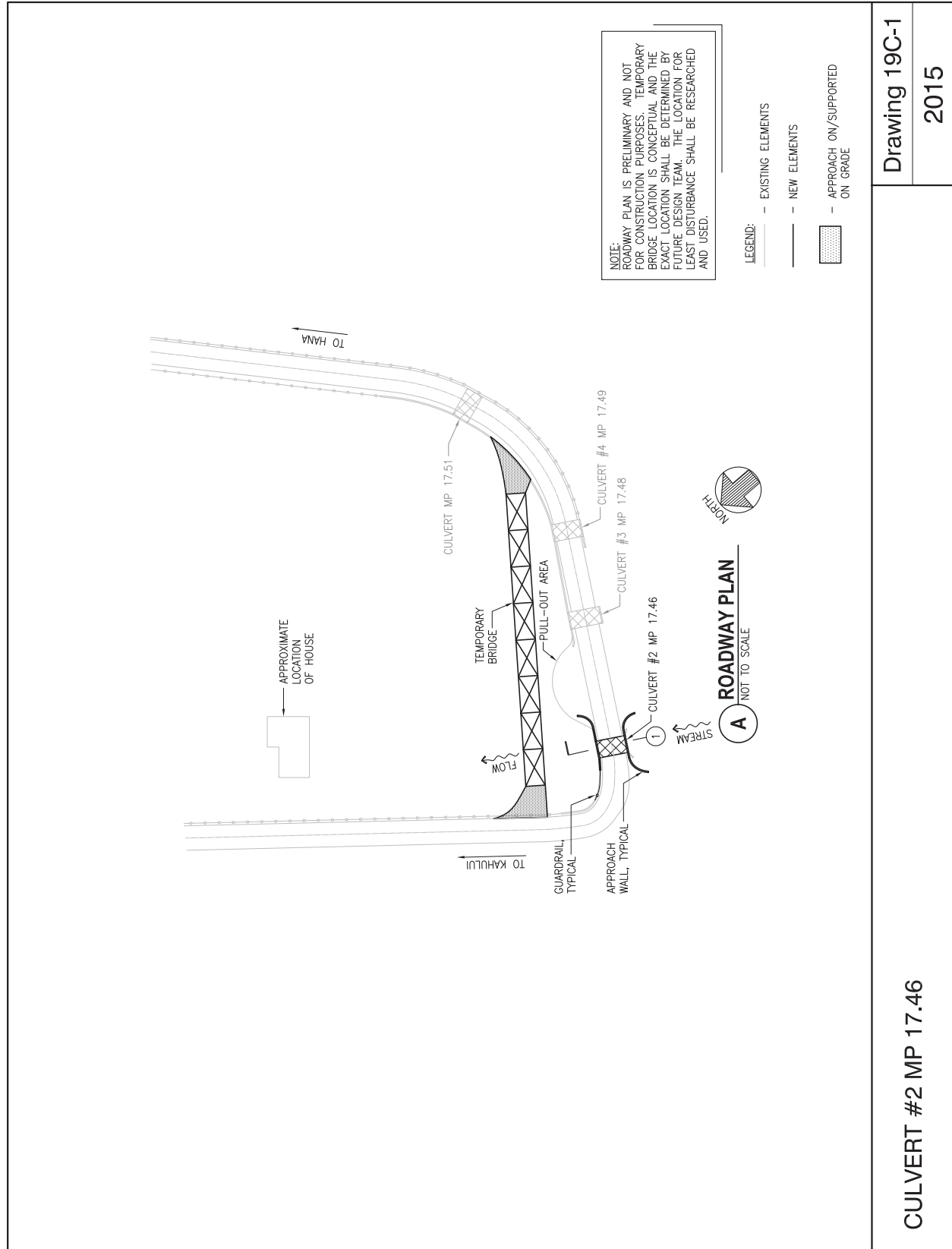
- Add Object Marker Type 3 - Right (OM3-R) to East Bound

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #2 at this time.

# CURRENT DRAWINGS



CULVERT #2 MP 17.46

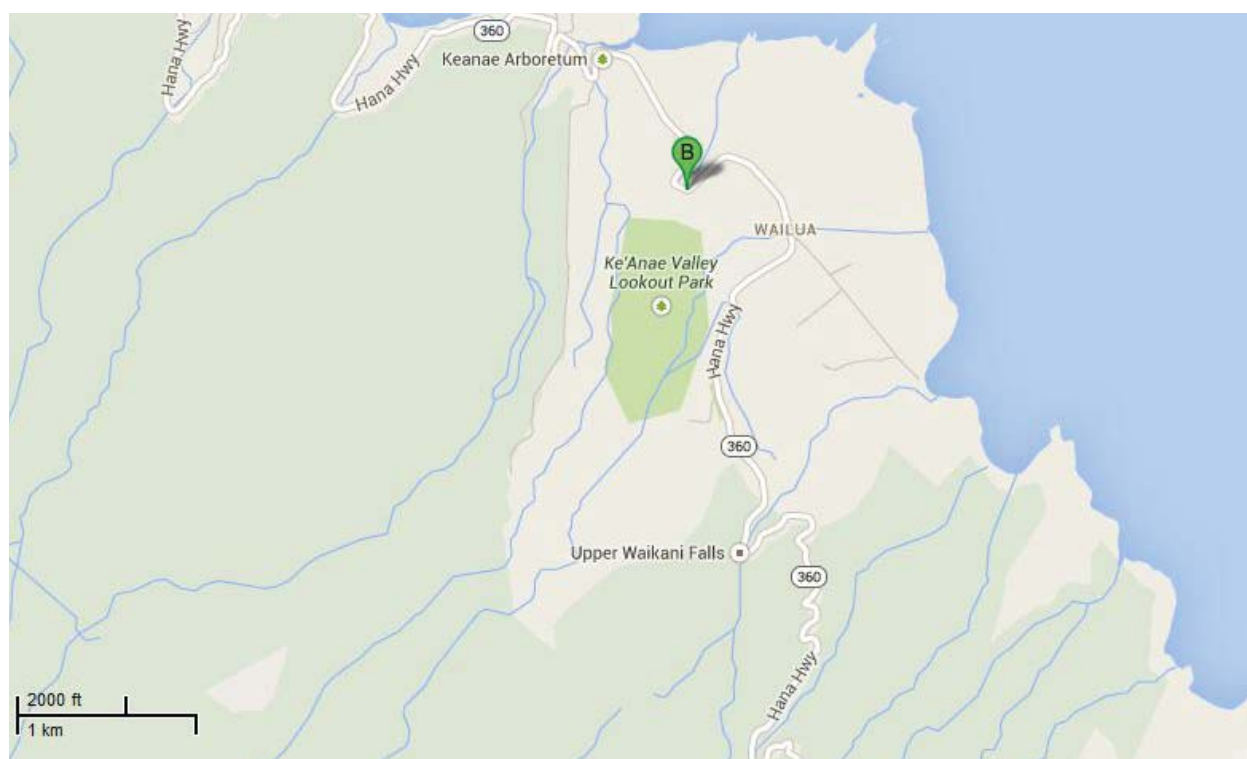
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Culvert #3 20C





<b>Culvert Number</b>					<b>Island</b>	Maui
<b>Date of Construction</b>	circa 1937-1940				<b>Route</b>	Hana Highway
<b>Treatment Recommendation</b>	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 51m 04s
<b>Longitude</b>	156d 08m 31s
<b>Mile Point</b>	17.48

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 25.00 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	16 feet (upstream) & 20.50 feet (downstream)
<b>Clear Height</b>	4 feet (upstream) & 8 feet (downstream) (approx)
<b>Deck Width</b>	Curb-to-Curb = 22.16 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM (upstream) &amp; Concrete (downstream) Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Solid Parapets
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 24 inches</li><li>• Downstream Railing Height = 30 inches</li></ul>
<b>Parapet Profile</b>	<ul style="list-style-type: none"><li>• No Cap</li><li>• Flat Parapet</li></ul>
<b>Parapet Inscription</b>	None

# CULVERT INFORMATION

## Culvert Features

Culvert #3 is located at mile point 17.48 and has a clear opening of approximately 16 feet wide by 4 feet high at the upstream end, and 20.50 feet wide by 8 feet high at the downstream end. The culvert is 25.00 feet long. According to the HAER report, the original date of construction is unknown, but the culvert was widened on the downstream side circa 1937-1940.<sup>1</sup> The top slab and walls are concrete with CRM and concrete abutment walls, and the bottom is an unlined channel.



*Solid concrete parapet, downstream side  
Courtesy of NOEI*



*Solid concrete parapet, upstream side  
Courtesy of NOEI*



*Kahului approach to Culvert #3 toward Hana  
Courtesy of NOEI*

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<sup>1</sup> "Hana Belt Road," Historic American Engineering Record, HAER HI-75 (2005).

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Waianu
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	Circa 1937-1940
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	<ul style="list-style-type: none"> <li>• Walker Site 94, the Heiau of Ohia, was once located approximately 115 meters southeast of historic Culvert #4. The <i>heiau</i> was documented by Walker as, "Stones removed to build pig pen, and outlines thus lost. Probably an agricultural <i>heiau</i> built by a chief named Kaimuki."</li> </ul>
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> <li>• Taro farm located on downstream side</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM (upstream) &amp; Concrete (downstream) Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Solid Parapets</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>



# CULVERT INFORMATION

## Significance & Context

### Archaeological / Cultural Significance

Culvert #3 is located at the Ohia Stream crossing of Hana Highway, Route 360,<sup>2</sup> within Waianu Ahupuaa.<sup>3</sup> The Hawaiian word *ohia* is most commonly used to refer to a type of tree (*Metrosideros macropus*), but may also be used for a tomato, a native variety of sugar cane, a variety of taro, a red birthmark, and for the word “tabooed.”<sup>4</sup>

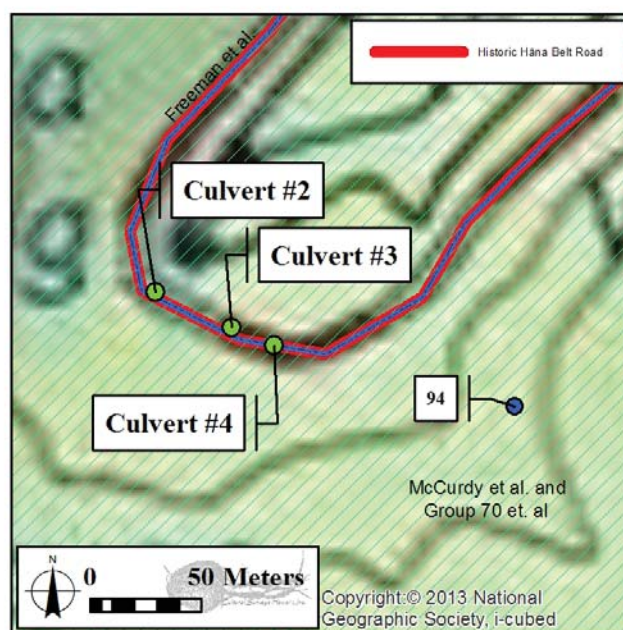
The Keanae region is described as a unique wet-taro growing area developed by the early inhabitants for irrigated taro with a *loi* complex that covered the peninsula. The Native Hawaiian mythology states that the god Kane accompanied by Kanaloa, thrust his *kauila* staff into solid rock and water gushed forth. Additionally, Ashdown stated that the Lualailua fishponds were located at Keanae, and that they were considered sacred, or *wahi pana*.<sup>5</sup>

The initial occupation of this portion of Maui first occurred along the coastal region about A.D. 1200.<sup>6</sup> The accepted pre-contact settlement pattern for the region of Keanae/Wailuanui centers on the series of occupational episodes that utilized the Palauhulu Stream for taro (*Colocasia esculenta*) cultivation.

Refer to Section G, Appendix 1, Section 3.1.2.5 for the regional history of Keanae, and to Section G, Appendix 1, Figure 10 for nearby archaeological study areas.<sup>7, 8, 9</sup>

### Adjacent Cultural Sites

Walker Site 94, the Heiau of Ohia, was once located approximately 135 meters southeast of historic Culvert #3. The *heiau* was documented by Walker as, “Stones removed to build pig pen, and outlines thus



2 U.S. Geological Survey, ed., *Keanae Quadrangle, Hawaii*, 7.5 Minute Series (United States Department of the Interior, 1992).

3 W. D. Alexander, “Map of the Koolau Coast Maui: From Wahinepee to Kekuapaawela,” registered map no. 1065 (1879).

4 Mary Kawena Pukui and Samuel H. Elbert, *Hawaiian Dictionary: Hawaiian-English, English-Hawaiian*, rev. and enl. ed. (Honolulu: University of Hawaii Press, 1986).

5 Inez MacPhee Ashdown, *Ke Alaloe O Maui – Authentic History and Legends of the Valley Isle* (Wailuku: Kama’aina Historians, Inc., 1971).

6 Alan E. Haun, David Henry, and Maria Orr, “Archaeological Inventory Survey, Wai’ānapanapa State Park, Lands of Honokalani, Wākiu and Kawaipapa, Hāna District, Island of Maui,” Haun & Associates (Keaau: 2004).

7 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

8 Group 70 International, Inc., Davianna McGregor, Ph.D., and Cultural Surveys Hawaii, Inc., “Kalo Kanu o ka ‘Aina, A Cultural Landscape Study of Ke’anae and Wailuanui, Ko’olau District, Island of Maui,” prepared for the County of Maui Planning Department (1995).

9 Todd D. McCurdy, Tanya L. Lee-Greig, and Hallett H. Hammatt, “Literature Review and Field Inspection for the Proposed Hana Highway Improvements Huelo to Hāna, Phase II Project, Makaīwa to Ko’olau Ahupua’a, Hāna District, Maui Island TMK: [2] 1-1-001:999; [2] 1-1-002:999; [2] 1-1-007:999; [2] 1-1-008:999; [2] 1-1-009:999 and [2] 1-2-001:999 (pors),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2014).

# CULVERT INFORMATION

lost. Probably an agricultural *heiau* built by a chief named Kaimuki.”<sup>10</sup> Walker was not able to relocate the site, and Soehren was unable to identify the site during his 1963 survey as well.<sup>11</sup> Refer to Section G, Appendix 1, Table 1: Heiau sites identified by Walker (1931) along the historic portion of Hana Highway, and to the adjacent figure for approximate location of previous *heiau* relative to Culvert #3.

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<sup>10</sup> Winslow Walker, *Archaeology of Maui*, 1931, manuscripts on file, Bishop Museum Archives, Honolulu.

<sup>11</sup> Lloyd J. Soehren, *An Archaeological Survey of Portions of East Maui, Hawai'i*, Bernice Pauahi Bishop Museum (Honolulu: 1963).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	Two Lanes
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

The invert of the culvert is approximately 9 feet below the roadway pavement. There is a 6-inch waterline that runs along the upstream end of the culvert.

The roadway above the culvert is striped for two lanes and includes, allowing vehicles to travel across the span of the culvert without yielding to oncoming traffic.

Culvert #3 receives storm water runoff from a 12-acre drainage area (approximate) and consists of mostly forest type of terrain. The downstream end of the culvert consists of an unnamed shallow stream that travels towards the ocean. The absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Culvert #3 is a two-lane reinforced concrete slab culvert. CRM walls are located at each corner of the approaches to the culvert. The upstream and downstream concrete parapets have a height of 24 inches and 30 inches, respectively. Neither parapet has been crash-tested for a TL-2.

The current curb-to-curb dimension is 22.16 feet, which for a two-lane culvert does not meet the design criteria minimum of 24 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).



# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #3 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #3 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

There are no record drawings for this culvert. It is recommended to widen the deck on the downstream side, scan the deck for reinforcing, and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the new railings and a 40-ton load carrying capacity. The widened deck slab shall be designed to cantilever off the existing slab and abutments. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum. Thickness of the fill on the culvert, between the deck and the asphaltic concrete overlay, shall be limited as shown on the following drawings so as to not affect the height of the new crash-tested railings (refer to "Railings/Parapets" section for more information). As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

# RECOMMENDATIONS

## **CRM Approach Walls**

The existing CRM walls at the approaches to the culvert do not meet the TL-2 crash requirements and cannot act as the culvert's traffic features. The existing CRM approach walls are recommended to be replaced with a reinforced concrete wall with a new natural rock façade. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The upstream and downstream Kahului and upstream Hana approach corners have adequate room to curve the approach walls away from the roadway so as to eliminate the potential of a blunt end collision occurring.



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges:

#19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## **Railings / Parapets**

The culvert parapets currently do not meet TL-2 crash requirements. The upstream concrete parapet is recommended to be replaced with a reinforced concrete wall with a new natural rock façade. Since the approach walls are similar to the upstream parapet, it is recommended to construct the upstream parapet monolithic with the approach walls. Therefore, the upstream parapet will be replaced with a stone masonry guardwall (See Section G, Appendix 5 for more information). The downstream parapet will be replaced with a similarly designed reinforced concrete parapet, such as the vertical concrete barrier rail (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the existing deck is recommended to determine whether it can support the design loads of the parapets (refer to "Deck" section). Also, drainage should be provided through the base of each parapet.

# RECOMMENDATIONS

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable. Also, new concrete railing heights, as measured from the deck, shall not be less than existing railings. As a design consideration, future design team shall consult with FHWA, HDOT, and SHPD whether the FHWA approved concrete crash-tested railing design height can be changed to match existing conditions and have a straight exterior surface.

## ***Foundations, Wingwalls, & Abutments***

The CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current material composition of the CRM/concrete abutments and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The concrete portions of the culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert's lifespan. If it is determined necessary to rehabilitate the CRM and concrete abutments, and foundations they are recommended to be replaced in-kind.

If it is determined necessary to rehabilitate the CRM/concrete abutments, it is recommended that the concrete portions be replaced in-kind and CRM portions be replaced with a reinforced concrete structure with a new rock façade. The appearance of the reconstructed CRM façade portions shall closely match that of the original historic craftsmanship along Hana Highway.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to "Deck" section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver's visibility should be trimmed or removed per an approved landscape plan. Signage shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

- Add Object Markers to approach walls

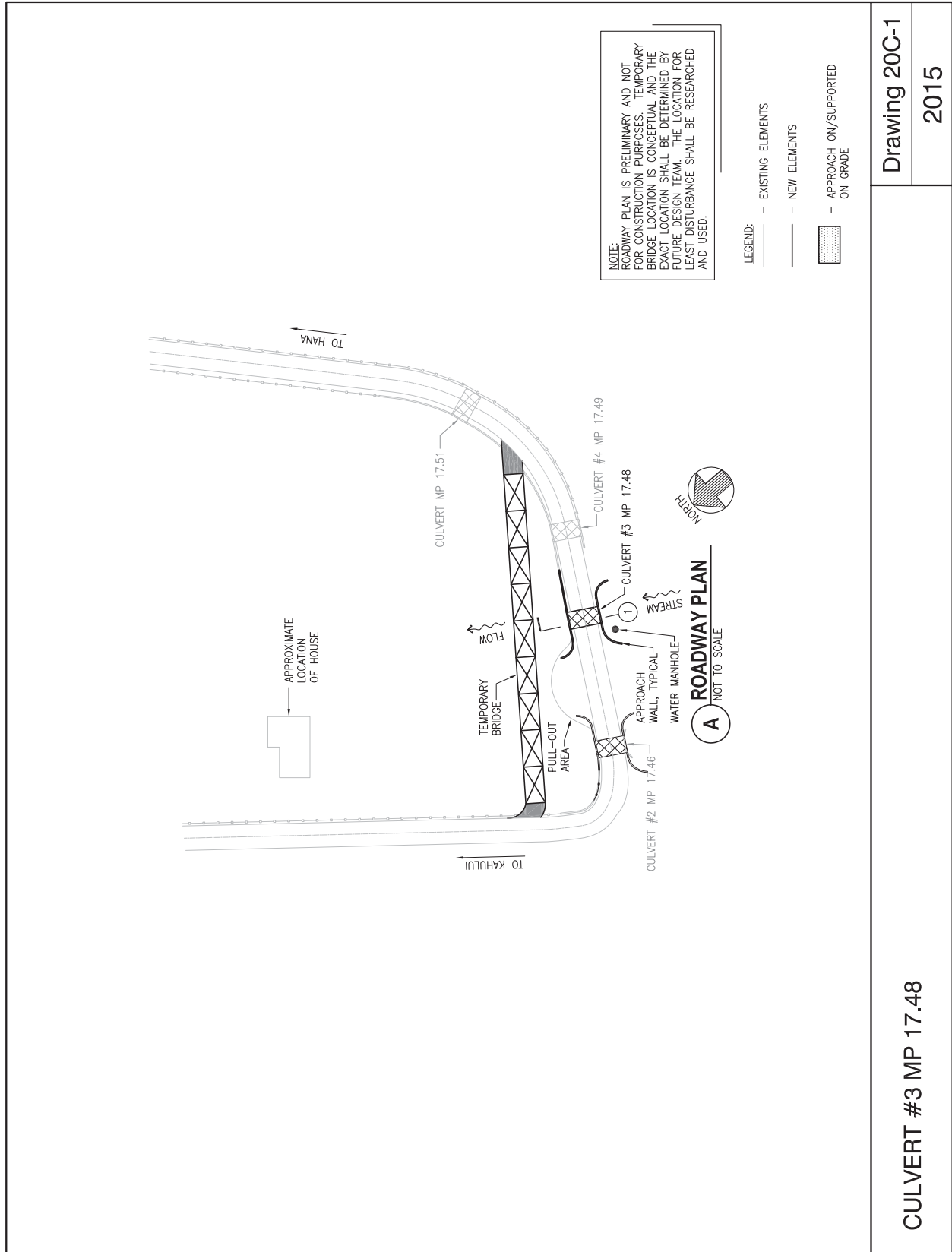
# RECOMMENDATIONS

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #3 at this time.

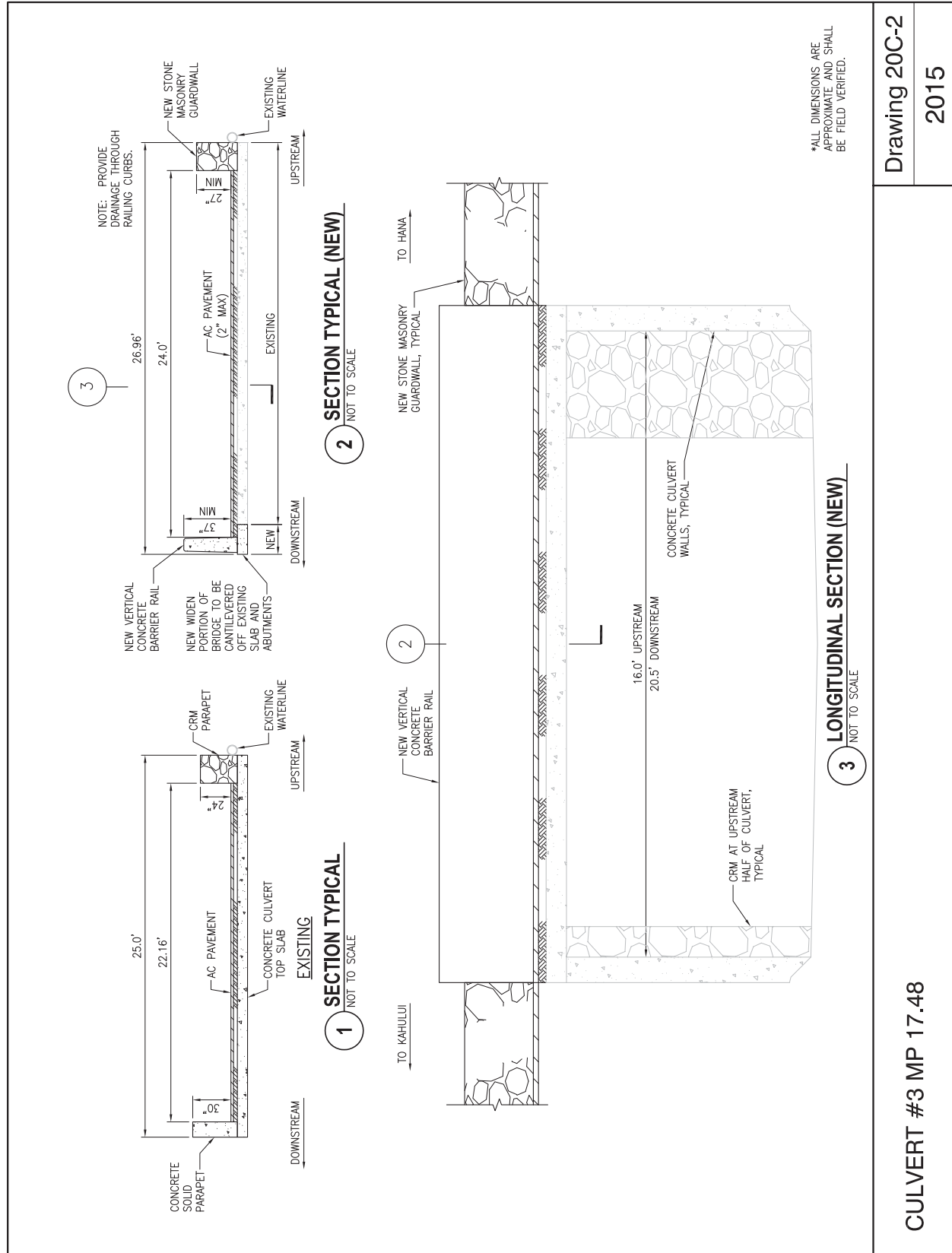
# CURRENT DRAWINGS



CULVERT #3 MP 17.48

Drawing 20C-1

2015

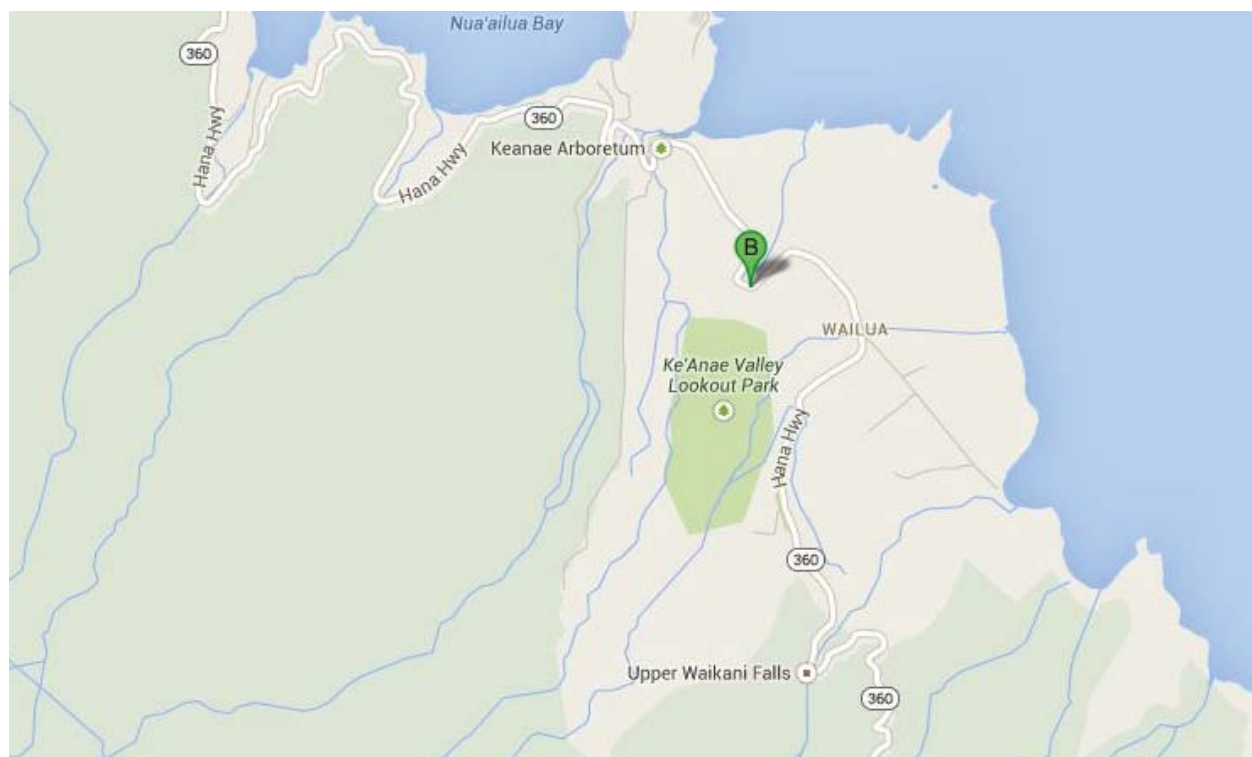


Culvert #4 21C





Culvert Number					Island	Maui
Date of Construction	circa 1937-1940				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 51m 03s
<b>Longitude</b>	156d 08m 10s
<b>Mile Point</b>	17.49

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 22.50 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	12.67 feet (upstream) & 13.08 feet (downstream)
<b>Clear Height</b>	7 feet (upstream) & 10.5 feet (downstream) (approx)
<b>Deck Width</b>	Curb-to-Curb = 21.16 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM (upstream) &amp; Concrete (downstream) Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Solid Parapets
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 24 inches</li><li>• Downstream Railing Height = 28 inches</li></ul>
<b>Parapet Profile</b>	<ul style="list-style-type: none"><li>• No Cap</li><li>• Flat Parapet</li></ul>
<b>Parapet Inscription</b>	None



# CULVERT INFORMATION

## Culvert Features

Culvert #4 is located at mile point 17.49 and has a clear opening of approximately 12.7 feet wide by 7 feet high at the upstream end and 13.1 feet wide by 10.5 feet high at the downstream end. The culvert is 22.50 feet long. According to the HAER report, the original date of construction is unknown, but the culvert was widened on the downstream side circa 1937-1940.<sup>1</sup> The top slab and walls are concrete and the bottom is an unlined channel.



*Solid concrete parapet, downstream side*  
Courtesy of FAI



*Solid concrete parapet, upstream side*  
Courtesy of FAI



*CRM abutment, Kahului and Hana sides*  
Courtesy of FAI



*Downstream approach wall, Kahului side*  
Courtesy of FAI

<sup>1</sup> "Hana Belt Road," Historic American Engineering Record, HAER HI-75 (2005).

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Waianu
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	Circa 1937-1940
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	<ul style="list-style-type: none"> <li>• Walker Site 94, the Heiau of Ohia, was once located approximately 115 meters southeast of historic Culvert #4. The <i>heiau</i> was documented by Walker as, "Stones removed to build pig pen, and outlines thus lost. Probably an agricultural <i>heiau</i> built by a chief named Kaimuki."</li> </ul>
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation,</li> <li>• Taro farm located on downstream side</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM (upstream) &amp; Concrete (downstream) Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Solid Parapets</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> <li>• Non-historic cementitious materials on face of culvert walls and wingwalls</li> </ul>

# CULVERT INFORMATION

## Significance & Context

### Archaeological / Cultural Significance

Culvert #4 is located at the Ohia Stream crossing of Hana Highway, Route 360,<sup>2</sup> within Waianu Ahupuaa.<sup>3</sup> The Hawaiian word *ohia* is most commonly used to refer to a type of tree (*Metrosideros macropus*), but may also be used for a tomato, a native variety of sugar cane, a variety of taro, a red birthmark, and for the word “tabooed.”<sup>4</sup>

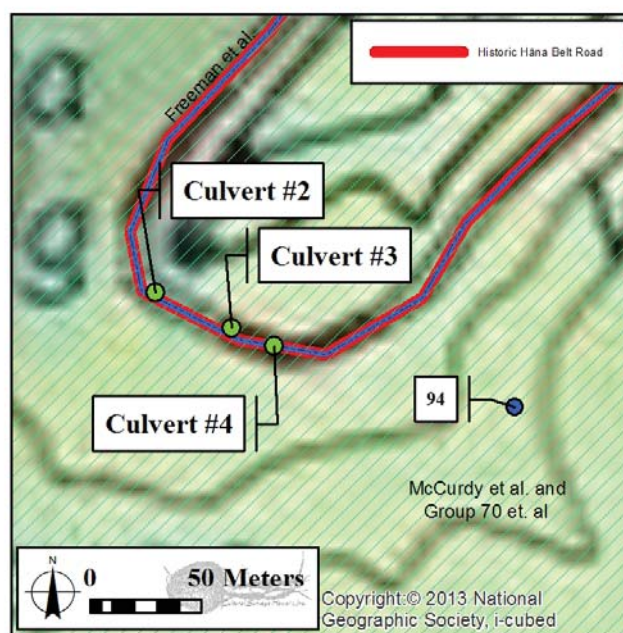
The Keanae region is described as a unique wet-taro growing area developed by the early inhabitants for irrigated taro with a *loi* complex that covered the peninsula. The Native Hawaiian mythology states that the god Kane accompanied by Kanaloa, thrust his *kauila* staff into solid rock and water gushed forth. Additionally, Ashdown stated that the Lualailua fishponds were located at Keanae, and that they were considered sacred, or *wahi pana*.<sup>5</sup>

The initial occupation of this portion of Maui first occurred along the coastal region about A. D. 1200.<sup>6</sup> The accepted pre-contact settlement pattern for the region of Keanae/Wailuanui centers on the series of occupational episodes that utilized the Palauhulu Stream for taro (*Colocasia esculenta*) cultivation.

Refer to Section G, Appendix 1, Section 3.1.2.5 for the regional history of Keanae, and to Section G, Appendix 1, Figure 10 for nearby archaeological study areas.<sup>7, 8, 9</sup>

### Adjacent Cultural Sites

Walker Site 94, the Heiau of Ohia, was once located approximately 115 meters southeast of historic Culvert #4. The *heiau* was documented by Walker as, “Stones removed to build pig pen, and outlines thus



2 U.S. Geological Survey, ed., *Keanae Quadrangle, Hawaii, 7.5 Minute Series* (United States Department of the Interior, 1992).

3 W. D. Alexander, “Map of the Koolau Coast Maui: From Wahinepee to Kekuapaawela,” registered map no. 1065 (1879).

4 Mary Kawena Pukui and Samuel H. Elbert, *Hawaiian Dictionary: Hawaiian-English, English-Hawaiian*, rev. and enl. ed. (Honolulu: University of Hawaii Press, 1986).

5 Inez MacPhee Ashdown, *Ke Alaloe O Maui – Authentic History and Legends of the Valley Isle* (Wailuku: Kama’aina Historians, Inc., 1971).

6 Alan E. Haun, David Henry, and Maria Orr, “Archaeological Inventory Survey, Wai’ānapanapa State Park, Lands of Honokalani, Wākiu and Kawaipapa, Hāna District, Island of Maui,” Haun & Associates (Keaau: 2004).

7 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

8 Group 70 International, Inc., Davianna McGregor, Ph.D., and Cultural Surveys Hawaii, Inc., “Kalo Kanu o ka ‘Aina, A Cultural Landscape Study of Ke’anae and Wailuanui, Ko’olau District, Island of Maui,” prepared for the County of Maui Planning Department (1995).

9 Todd D. McCurdy, Tanya L. Lee-Greig, and Hallett H. Hammatt, “Literature Review and Field Inspection for the Proposed Hana Highway Improvements Huelo to Hāna, Phase II Project, Makaīwa to Ko’olau Ahupua’a, Hāna District, Maui Island TMK: [2] 1-1-001:999; [2] 1-1-002:999; [2] 1-1-007:999; [2] 1-1-008:999; [2] 1-1-009:999 and [2] 1-2-001:999 (pors),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2014).

# CULVERT INFORMATION

lost. Probably an agricultural *heiau* built by a chief named Kaimuki.”<sup>10</sup> Walker was not able to relocate the site, and Soehren was unable to identify the site during his 1963 survey as well.<sup>11</sup> Refer to Section G, Appendix 1, Table 1: Heiau sites identified by Walker (1931) along the historic portion of Hana Highway, and to the adjacent figure for approximate location of previous *heiau* relative to Culvert #4.

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<sup>10</sup> Winslow Walker, *Archaeology of Maui*, 1931, manuscripts on file, Bishop Museum Archives, Honolulu.

<sup>11</sup> Lloyd J. Soehren, *An Archaeological Survey of Portions of East Maui, Hawai'i*, Bernice Pauahi Bishop Museum (Honolulu: 1963).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	Two Lanes
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# RECOMMENDATIONS

## Civil & Traffic

The invert of the culvert is approximately 12 feet below the roadway pavement. There is a 6-inch waterline that runs along the upstream end of the culvert.

The roadway above the culvert is striped for two lanes, allowing vehicles to travel along the span of the culvert without yielding to oncoming traffic.

Culvert #4 receives storm water runoff from a 19.7-acre (approximate) drainage area and consists of mostly forest type of terrain. The downstream end of the culvert consists of an unnamed shallow stream that travels towards the ocean. The absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Culvert #4 is a two-lane reinforced concrete slab culvert. CRM walls are located at three corners of the approaches to the culvert. There is no approach wall at the upstream Kahului approach. The upstream and downstream concrete parapets have a height of 24 inches and 28 inches, respectively. Neither parapet has been crash-tested for a TL-2.

The current curb-to-curb dimension is 21.16 feet, which for a two-lane culvert does not meet the design criteria minimum of 24 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).



# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #4 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic bridges is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #4 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

There are no record drawings for this culvert. It is recommended to widen the deck on the downstream side, scan the deck for reinforcing, and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the new railings and a 40-ton load carrying capacity. The widened deck slab shall be designed to cantilever off the existing slab and abutments. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum. Thickness of the fill on the culvert, between the deck and the asphaltic concrete overlay, shall be limited as shown on the following drawings so as to not affect the height of the new crash-tested railings (refer to "Railings/Parapets" section for more information). As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

# RECOMMENDATIONS

## **CRM Approach Walls**

The existing CRM walls at the approaches to the culvert do not meet the TL-2 crash requirements and cannot act as the culvert's traffic features. The existing CRM approach walls are recommended to be replaced with a reinforced concrete wall with a new natural rock façade. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The upstream Kahului approach corner has adequate room to curve the approach wall away from the roadway so as to eliminate the potential of a blunt end collision occurring. The upstream and downstream Hana approach corners do not have adequate room for this; therefore, it is recommended to install guardrails and an end treatment at these corners after the stone masonry guardwall. Culvert #3 is in close proximity to this culvert; therefore, it is recommended to have the stone masonry guardwall be continuous between the downstream parapets.

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## **Railings / Parapets**

Of the three historic culverts along this stretch of Hana Highway, Culvert #4 is the only culvert with a reinforced concrete upstream and downstream parapet. The concrete parapets do not meet TL-2 crash requirements. To keep with the historic character of the adjacent culverts, it is recommended to replace the upstream parapet with a similar recommended design as Culverts #2 and #3. Therefore, the upstream parapet will be replaced with a stone masonry guardwall, which will be constructed monolithic with the approach walls (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The downstream parapet will be replaced with a similarly designed reinforced concrete



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

# RECOMMENDATIONS

parapet, such as the vertical concrete barrier rail (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the existing deck is recommended to determine whether it can support the design loads of the parapets (refer to “Deck” section above). Also, drainage should be provided through the base of each parapet.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable. Also, new concrete railing heights, as measured from the deck, shall not be less than existing railings. As a design consideration, future design team shall consult with FHWA, HDOT, and SHPD whether the FHWA approved concrete crash-tested railing design height can be changed to match existing conditions and have a straight exterior surface.

## ***Foundations, Wingwalls, & Abutments***

The CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current material composition of the CRM and concrete abutments and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The concrete portions of the culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert’s lifespan.

If it is determined necessary to rehabilitate the CRM/concrete abutments, it is recommended that the concrete portions be replaced in-kind and CRM portions be replaced with a reinforced concrete structure with a new rock façade. The appearance of the reconstructed CRM façade portions shall closely match that of the original historic craftsmanship along Hana Highway.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*, 2009 edition by the FHWA or the most

# RECOMMENDATIONS

current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

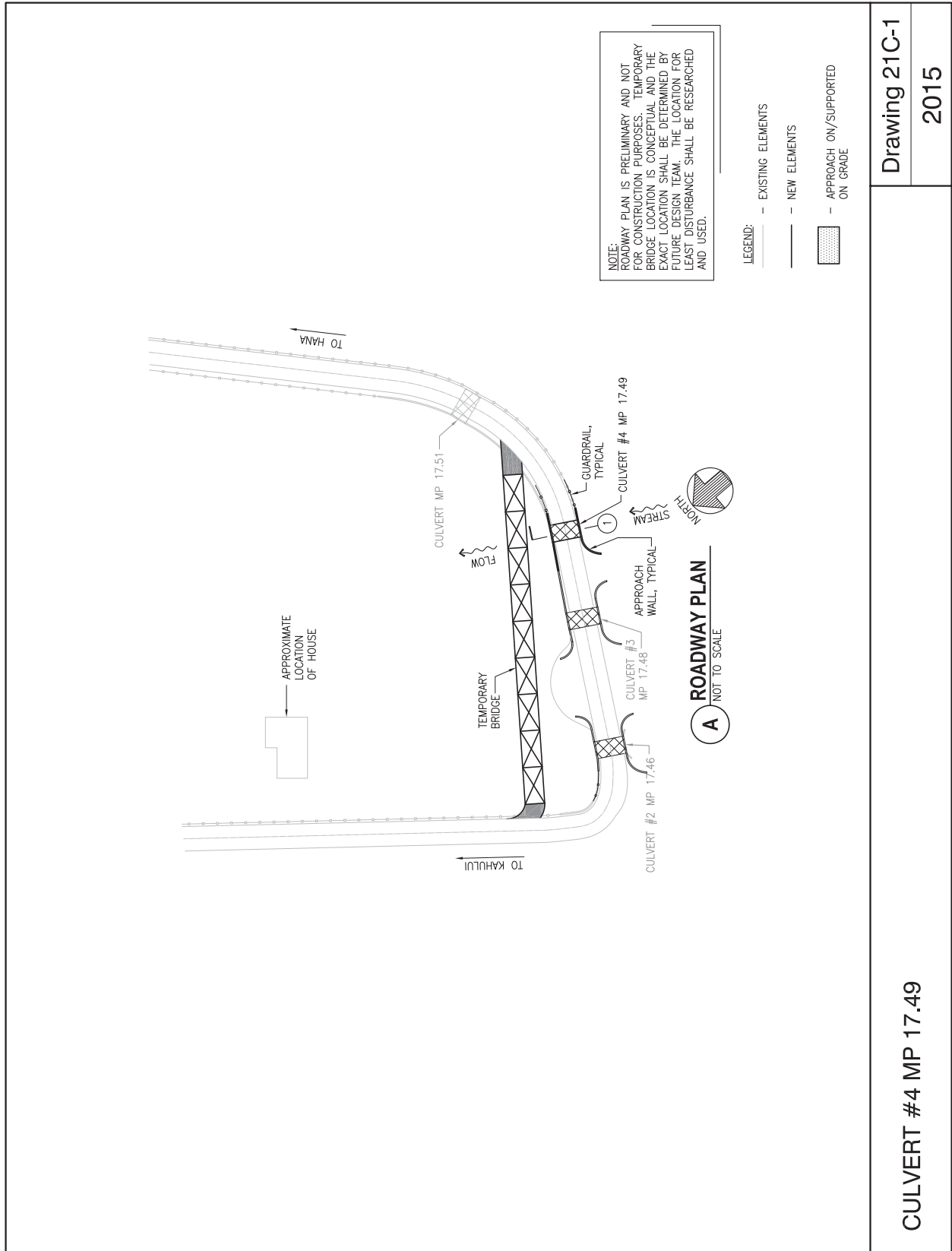
- Add Object Markers to approach walls

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #4 at this time.

# CURRENT DRAWINGS



CULVERT #4 MP 17.49

Drawing 21C-1

2015



**NOT TO SCALE**

2

**1** SECTION TYPICAL  
NOT TO SCALE

**NOT TO SCALE**

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\*ALL DIMENSIONS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.

Drawing 21C-2

2015

CULVERT #4 MP 17.49

Waiokamilo  
Culvert

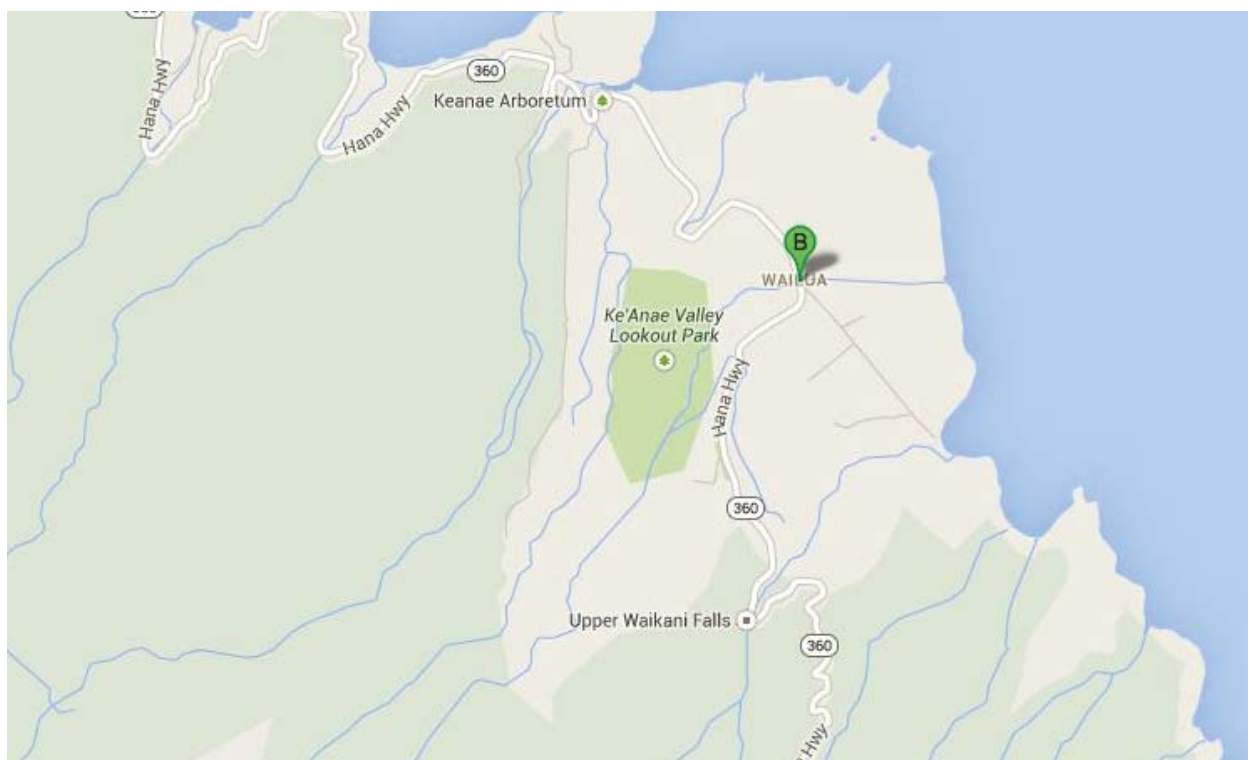
25C





## WAIOKAMILO CULVERT

Culvert Number					Island	Maui
Date of Construction	1921				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 50m 55s
<b>Longitude</b>	156d 0m 10s
<b>Mile Point</b>	18.08

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 44.5 feet (approx)
<b>Number of Spans</b>	1
<b>Clear Span</b>	13.67 feet
<b>Clear Height</b>	6 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 42.50 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• Concrete Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• Concrete Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Open Greek Cross
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 33.5 inches with 52" headwall (includes girder height)</li><li>• Downstream Railing Height = 33.5 inches 52" headwall (includes girder height)</li></ul>
<b>Baluster Dimensions</b>	<ul style="list-style-type: none"><li>• Posts = 6 inches x 6 inches</li><li>• Decorative Panels = 1 foot 7 inches (h) x 1 foot (w)</li><li>• Posts and Panels spaced approx. 1 foot 6 inches on-center</li><li>• End posts = 1 foot 9 inches x 1 foot 9 inches</li></ul>
<b>Parapet Cap Profile</b>	<ul style="list-style-type: none"><li>• Stepped Cap</li><li>• Railing cap = 6 inches x 12 inches</li></ul>



# CULVERT INFORMATION

## Culvert Features

Waiokamilo Culvert is located at mile point 18.08 and has a clear opening of approximately 13.7 feet wide by 6 feet high. The culvert is 44.5 feet long. The top slab and walls are concrete and the bottom is an unlined channel.



*Setting of Waiokamilo Culvert  
Courtesy of NOEI*



*Greek cross parapet, upstream side  
Courtesy of NOEI*



*Greek cross parapet, downstream side  
Courtesy of NOEI*



*Concrete abutment  
Courtesy of NOEI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Pauwalu and Wailuanui
<b>Designer / Builder</b>	County Engineer's Department - D. K. Kapohakimohewa, Designer Plans approved by Joseph Matson, Jr., County Engineer (1937 alteration plan)
<b>Historic Drawings</b>	November 1937
<b>Alterations</b>	Widened and installed new parapets in 1937
<b>Replacement</b>	None
<b>Preservation Priority</b>	Exceptional Culvert: Distinctive Parapets/Railings
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> <li>• One of two structures with open Greek cross parapets on Hana Highway, State Route 360</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	<ul style="list-style-type: none"> <li>• Walker Site 88, the former Kamokukupeu Heiau, was documented as having been located approximately 78 meters southwest of Waiokamilo Culvert, but was recorded as destroyed by Walker.</li> </ul>
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Rural residential</li> <li>• Adjacent to snack shops</li> <li>• Open clearing with dense vegetation around stream</li> <li>• Adjacent to "Y" intersection with Lower Wailua Road</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• Concrete Culvert Walls</li> <li>• Concrete Wingwall</li> <li>• Concrete Open Greek Cross Railings (built as a set with Waiokamilo Stream Bridge)</li> <li>• Stepped railing cap</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Attached guardrail on Kahului upstream side</li> </ul>

# CULVERT INFORMATION

## Significance & Context

### ***Archaeological / Cultural Significance***

The place name Waiokamilo is defined as, “Kamilo's water. Stream. Koolau. Maui.”<sup>1</sup> The Waiokamilo Culvert is located near the village of Wailua and is adjacent to Waiokamilo Stream Bridge, which spans the Waiokamilo Stream dividing Pauwalu Ahupuaa and Wailuanui Ahupuaa.<sup>2, 3</sup>

According to a State of Hawaii DLNR report for the Waiokamilo Stream, the stream enters the ocean in the region of the Village of Wailua.<sup>4</sup> The Waiokamilo Stream originates in a narrow watershed, with its stream water directed to taro patches (*loi*) in Wailua for over one hundred years.

A cultural landscape study recorded the intensive use of the Keanae and Wailuanui region for taro, identified three separate field systems, and noted the processes by which community cooperation led to the field system operation.<sup>5</sup> According to Maly, water from the Waiokamilo Stream enters the Lakini *auwai* system of taro *loi* that includes *loi* above the Hana Highway and some 339 *loi* west of Wailua Nui Stream.<sup>6</sup>

Evidence of a cohesive population is perhaps best described by the first Europeans to visit Keanae. From the journal of William Richards, a Protestant missionary, comes information that the region between Honomanu and Wailua was densely populated:

*We went on board the canoe, and rowed a few miles, avoiding some difficult paries [steep cliffs]. After landing, we walked a few miles further, to Wailua, where we put up for the Sabbath. Very early the morning [of the Sabbath], the horns, summoning the people to the house of God, were heard in every direction; and we soon perceived that the call had not been heard with indifference. At the early hour, the house was thronged with attentive worshipers. [The next day] we examined the schools, which were large. About 10 oclock, A.M., the princess [Nahienaena] arrived, and addressed the people; after which, we proceeded on our way [to Hana].<sup>7</sup>*

According to *Kalo Kunu O Ka 'Aina a Cultural Landscape Study of Ke'Anae and Wailuanui, Island of Maui* (1995), over 490 Land Commission Awards (LCA) claimed taro patches of various sizes at Keanae and Wailuanui during the time

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1 Lorrin Andrews, *A Dictionary of the Hawaiian Language* (Honolulu: The Board of Commissioners of Public Archives of the Territory of Hawaii, 1922).

2 Hawaii Heritage Center, “Historic Culvert Inventory and Evaluation, Islands of Maui and Molokai” (Honolulu: 1990).

3 Joseph Iao, “Portion of Hamakualoa & Koolau Maui,” registered map no. 2482, Hawaii Territory Survey (1909).

4 State of Hawaii, Division of Aquatic Resources, *Report on Waiokamilo Stream, Maui, Hawaii*, prepared for the State of Hawaii, Commission on Water Resource Management, Department of Land and Natural Resources (2008).

5 Group 70 International, Inc., Davianna McGregor, Ph.D., and Cultural Surveys Hawaii, Inc., “Kalo Kanu o ka 'Aina, A Cultural Landscape Study of Ke'anae and Wailuanui, Ko'olau District, Island of Maui,” prepared for the County of Maui Planning Department (1995).

6 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).

7 William Richards, Lorrin Andrews, and Jonathan Green, “A Tour of Maui,” *The Missionary Herald, containing Proceedings of The American Board of Commissioners for Foreign Missions with a View of Other Benevolent Operations for the year 1829* (Boston: Crocker and Brewster for A.B.C.F.M., 1829).

# CULVERT INFORMATION

of the Great Mahele [beginning in 1848].<sup>8</sup> Several LCAs included claims for pools and fishponds. In addition, evidence of densely-grouped regional *heiau* and smaller shrines was the subject of specialized studies dating from the turn of the 20th century to more recent work by Maria E. Orr.<sup>9,10</sup>

Background research into the land use patterns of the surrounding vicinity indicated that the area was intensively used for pre-contact agricultural pursuits, permanent and temporary habitation and traditional ceremony, as well as historic-era agriculture represented by taro *loi*, sweet potato, rice, and other staple crop cultivation. Early settlement patterns for the area seem to have focused primarily on valley and gulch lands, from river mouths to *mauka* lands. In the river gulches, it is expected that the soils are rich and fertile and conducive to agriculture. In addition, the constant supply of fresh water would have supported fairly intense agricultural pursuits. Within these valleys intensive agriculture would have likely been taking place in association with habitation activities. Toward the river mouths, the widening gulches would have provided ample areas for small communities and access to marine resources, as well as additional *loi*.

Based on available archaeological evidence and interpretations, it is possible that historically significant subsurface cultural deposits representing both traditional and historic agriculture, as well as midden and other cultural material concentrations representing both traditional and historic habitation may occur within the area.

Refer to Section G, Appendix 1, Section 3.3.2 for the Settlement Pattern of the Koolau District in the Keanae and Wailuanui vicinity, and to Section G, Appendix 1, Figure 10 for nearby archaeological study areas.<sup>11, 12, 13</sup>

## ***Adjacent Cultural Sites***

Walker Site 88, the former Kamokukupeu Heiau, was documented as having been located approximately 78 meters southwest of Waiokamilo Culvert, but was recorded as destroyed by Walker.<sup>14</sup> Refer to Section G, Appendix 1, Table 1: Heiau sites identified by Walker (1931) along the historic portion of Hana Highway, and to figure below for approximate location in relation to Waiokamilo Culvert.

Haun and Henry conducted an archaeological inventory survey of approximately 4 acres at Pauwalu in Wailuanui Ahupuaa.<sup>15</sup> The inventory survey resulted in the identification of one historic property, SIHP -5237, consisting of an overhang (Feature A) and trail (Feature B) located approximately 120 meters southwest of Waiokamilo Culvert (refer

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8 Group 70 International, Inc., Davianna McGregor, Ph.D., and Cultural Surveys Hawaii, Inc., “Kalo Kanu o ka ‘Aina, A Cultural Landscape Study of Ke‘anae and Wailuanui, Ko‘olau District, Island of Maui,” prepared for the County of Maui Planning Department (1995).

9 Maria E. Orr, “A Preliminary Report on the Heiau of Hana and Their Significance, Past and Present,” Department of Anthropology, University of Hawaii (Honolulu: 1990).

10 Thomas G. Thrum, “Heiaus and Heiau Sites Throughout the Hawaiian Islands; Omitting Koas, or Places of Offering to Kuula, the Deity of Fisher Folk,” *The Hawaiian Annual* (1908), 38-42.

11 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākuāloa and Ko‘olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai‘i, Inc. (Wailuku: 2004).

12 Group 70 International, Inc., Davianna McGregor, Ph.D., and Cultural Surveys Hawaii, Inc., “Kalo Kanu o ka ‘Aina, A Cultural Landscape Study of Ke‘anae and Wailuanui, Ko‘olau District, Island of Maui,” prepared for the County of Maui Planning Department (1995).

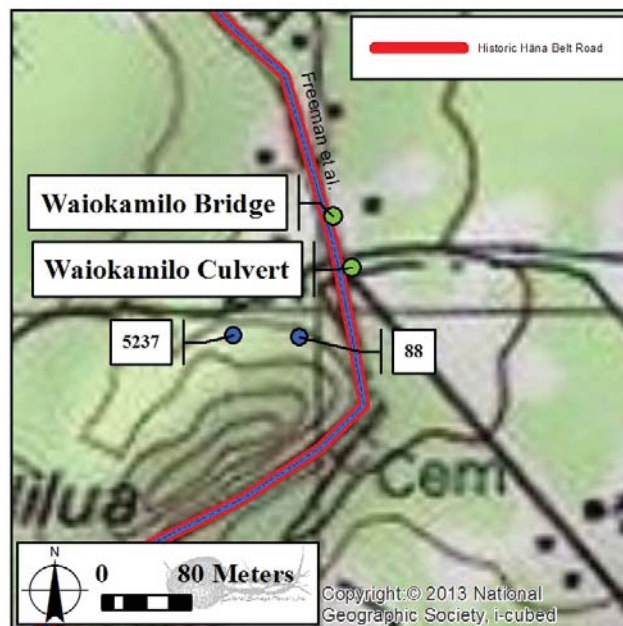
13 Alan E. Haun and Jack D. Henry, “Archaeological Inventory Survey TMK: 1-1-008:015, 023, Land of Pauwalu, Hana District, Island of Maui,” inventory survey, Haun & Associates (Keaau: 2003).

14 Winslow Walker, *Archaeology of Maui*, 1931, manuscripts on file, Bishop Museum Archives, Honolulu.

15 Ibid.

# CULVERT INFORMATION

to figure at right). The overhang was interpreted as a pre-contact temporary habitation shelter that was occupied between A. D. 1420-1650 and the trail as a transportation route. Refer to Section G, Appendix 1, Table 2: Previous archaeological studies conducted along Hana Highway, Route 360.



# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	Two-Lanes, adjacent part of the Y-intersection
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	None
<b>Civil Utilities</b>	Waterline upstream
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass upstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown



# RECOMMENDATIONS

## Civil & Traffic

The travel way above the Waiokamilo Culvert is striped for two-lane travel, allowing vehicles freely cross the culvert without yielding to oncoming traffic.

This culvert was observed to have constant, but relatively low constant flow traveling through the culvert. It receives such flow from the nearby Waiokamilo Stream and the absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Waiokamilo Culvert is a two-lane plus a part of the Y-intersection reinforced concrete slab culvert. The culvert is located near a Y-intersection and supports two lanes of traffic and part of the Y-intersection. A metal guardrail with an end treatment is located at the downstream Kahului approach. A metal guardrail with no end treatment is located at the upstream Kahului approach. No approach walls are located at the Hana approach. The upstream and downstream concrete parapets with decorative Greek cross panels have a height of 36 inches and 34 inches, respectively. The upstream and downstream parapets are not crash-tested for a TL-2.

The current curb-to-curb dimension is 42.50 feet, which for a two-lane culvert is adequate for this project's design criteria of 24 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Waiokamilo Culvert be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Waiokamilo Culvert is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form). In addition, undocumented burial mounds have been reported to Maui SHPD assistant archaeologist Jenny Pickett by Dr. Melissa Kirkendall. Precise location information is unavailable at this time; however, the mounds are reported to be located along the upstream side of Hana Highway between TMK (2) 1-1-08:002 and 004, approximately 200-500 meters south to southwest of the culvert. These mounds were recommended for further investigation and recording during the Environmental Assessment phase for Waiokamilo Bridge and/or Culvert. Due to the sensitive nature of these site types, it is also recommended that confidentiality of the site location should be respected.

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the bridge rehabilitation.

The name of this culvert shall be verified through a process to be determined during future development of a PA between the ACHP, SHPD, FHWA, and HDOT, including other concurring parties. Refer to Section G, Appendix 10. Hawaiian Place Names Research for further research and discussion.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

AC overlay thickness shall not obstruct the base or lower the height of the existing railings. If excessive AC overlay is present at the time of the future design team's site survey, then it is recommended to remove the excess AC overlay

# RECOMMENDATIONS

and reapply. As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

It is recommended to investigate the current material composition of the concrete deck to determine whether the deck is capable of supporting the new railings and a 40-ton load carrying capacity. This culvert should be scanned for reinforcing and have concrete core samples extracted. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

## **CRM Approach Walls**

Currently, there are no approach walls at this culvert; therefore, it is recommended to install approach walls at all approach corners. The approach wall will consist of a reinforced concrete wall with a natural rock façade to match the appearance of other culverts along Hana Highway. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The upstream Hana approach corner has adequate room to curve the approach wall away from the roadway as to eliminate the potential of a blunt end collision occurring. The remaining three approaches do not have adequate room for this; therefore, it is recommended to install guardrails and an end treatment at these corners after the stone masonry guardwall.



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

New approach walls shall be designed to be independent of the culvert railings; a space is recommended between railings and approach walls. A maximum space of 0.5 inches shall be maintained between culvert railings and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*). The approach walls shall also contain a concrete bridge name panel, pending confirmation of the Hawaiian place name by community and scholarly experts. Refer to Section A, Chapter 5. iii. a. *Approach Walls & Safety Features at the Approaches* for an example of the stone masonry guardwall with bridge name detail.

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI

# RECOMMENDATIONS

system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## ***Railings / Parapets***

The concrete culvert parapets do not meet TL-2 crash requirements. It is recommended to construct a crash-tested railing in front of the existing parapets. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are available, additional investigation of the deck is recommended (refer to “Deck” section). Also, drainage should be provided through the base of each railing curb.

At the time of design, the recommended railings shall be verified whether they meet current crash test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

It is recommended to investigate the current material composition of the concrete abutments and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert’s lifespan.

Following investigation of concrete abutments and foundations, if it is determined necessary that this component is to be replaced, the abutments and foundations are recommended to be replaced in-kind with a reinforced concrete structure.

## ***Load Rating***

Load rating is recommended to be completed on this culvert (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

- Add Object Markers to approach walls

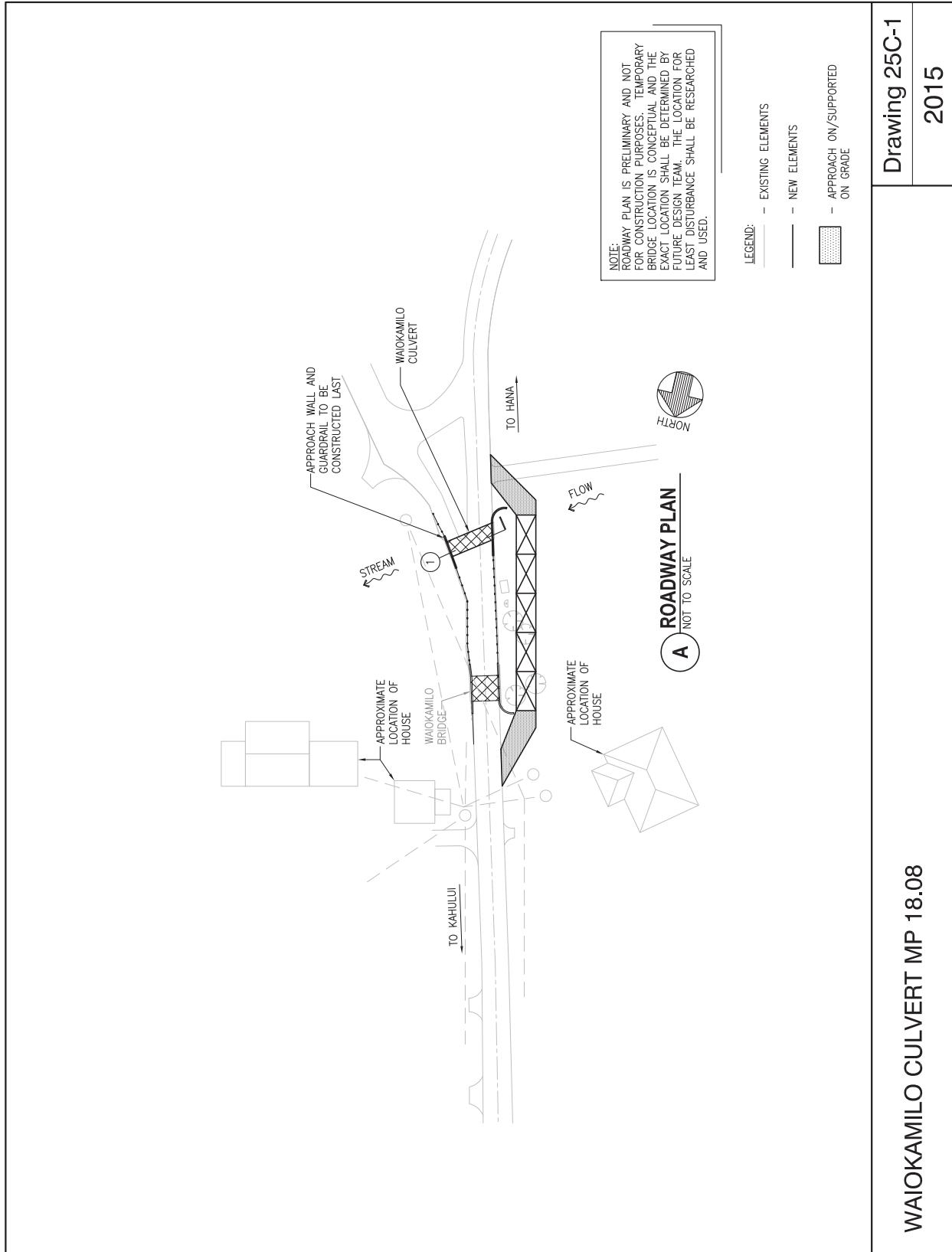
# RECOMMENDATIONS

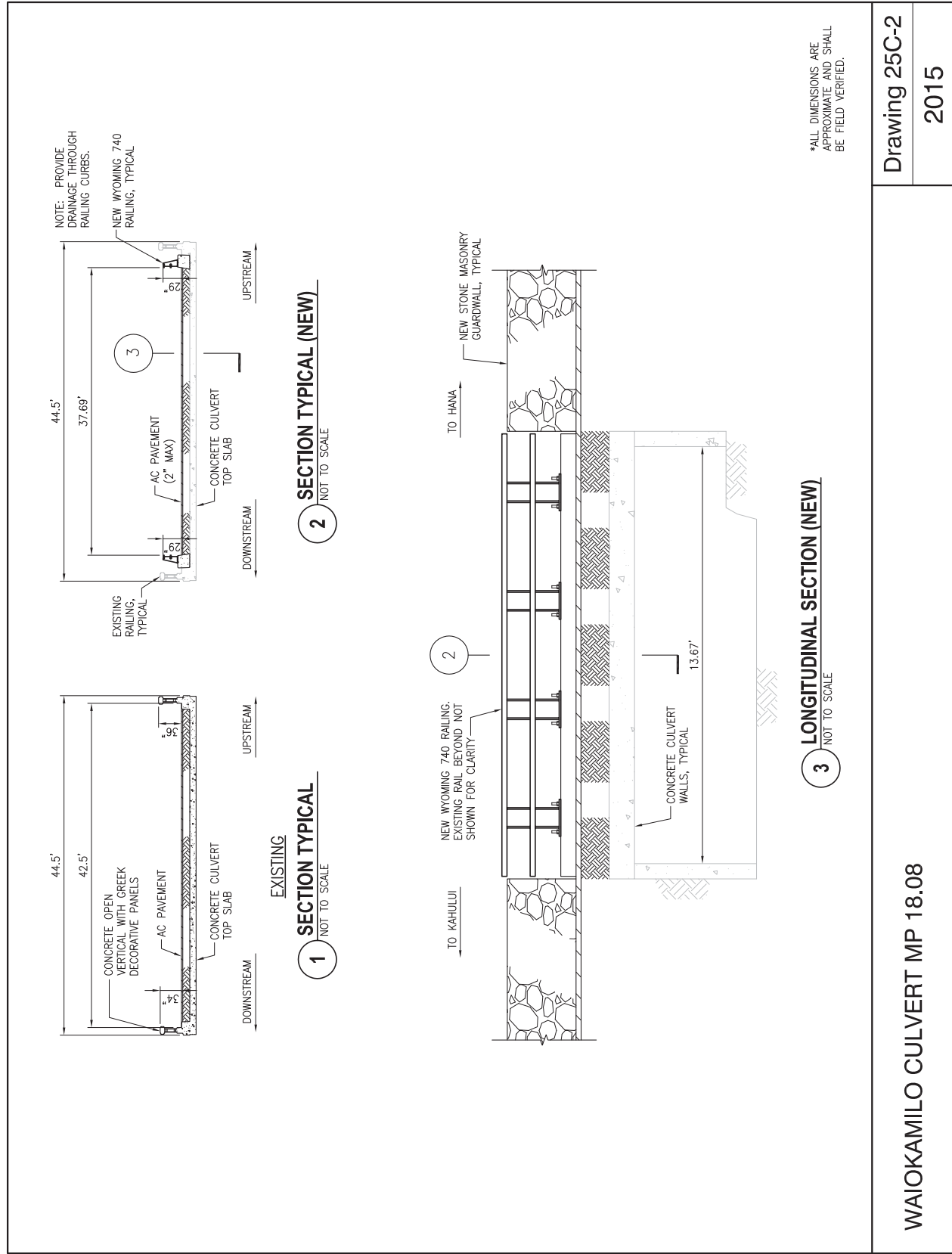
Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Waiokamilo Culvert at this time.

# CURRENT DRAWINGS





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East Hanawi  
Culvert

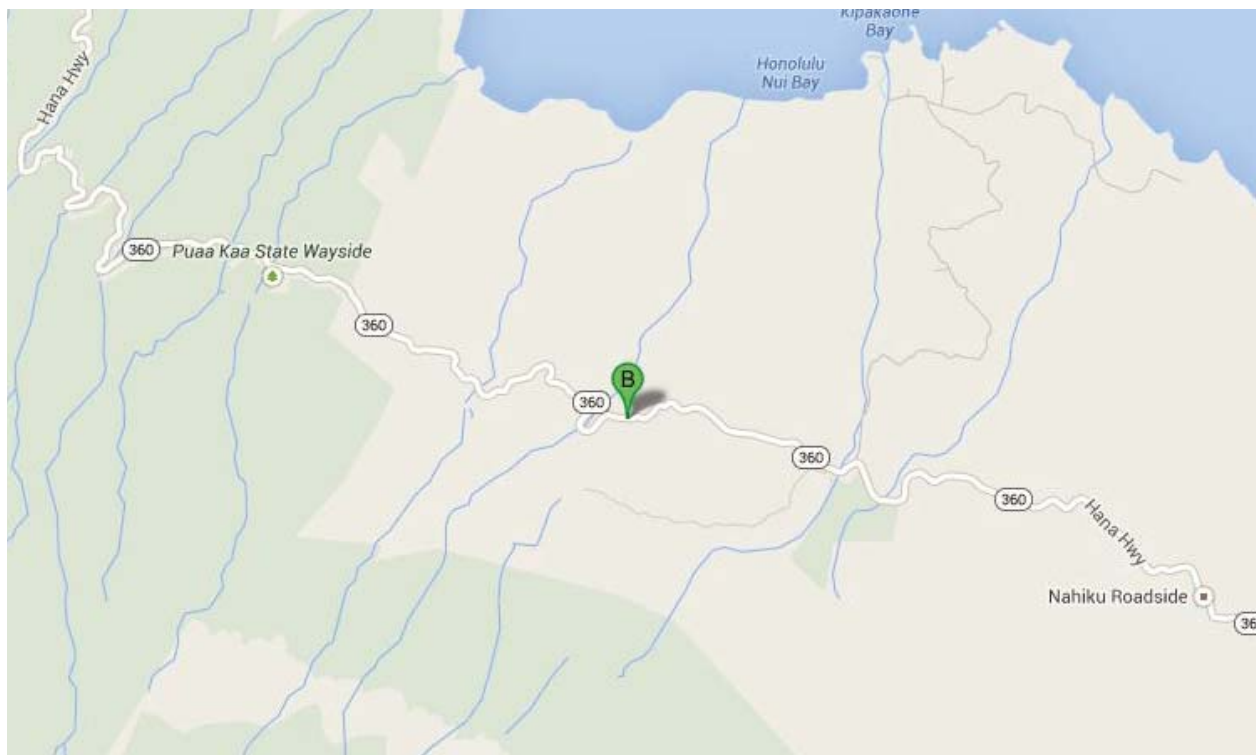
42C



42C

## EAST HANAWI CULVERT

Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 48m 36s
<b>Longitude</b>	156d 06m 26s
<b>Mile Point</b>	24.20

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 16.50 feet (approx)
<b>Number of Spans</b>	1
<b>Clear Span</b>	12 feet
<b>Clear Height</b>	7.5 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 15.10 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• Concrete Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Solid Panel Parapets
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 23.5 inches</li><li>• Downstream Railing Height = 26 inches</li></ul>
<b>Parapet Profile</b>	<ul style="list-style-type: none"><li>• Saddle Coping Cap</li><li>• Parapet with Exterior Paneled Face</li></ul>
<b>Parapet Inscription</b>	None

# CULVERT INFORMATION

## Culvert Features

East Hanawi Culvert is located at mile point 24.20 and has a clear opening of approximately 12 feet wide by 7.5 feet high. The culvert is 16.5 feet long. The top slab and walls are concrete and the bottom is an unlined channel.



*Culvert elevation, upstream side  
Courtesy of NOEI*



*Solid concrete parapet with saddle coping, upstream side  
Courtesy of NOEI*



*Solid concrete parapet with saddle coping, downstream side  
Courtesy of NOEI*



*Upstream CRM approach wall, Kahului side  
Courtesy of FAI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Hopenui
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Culvert spans a small stream</li> <li>• Open, partly shaded area with a view to the ocean</li> <li>• Mossy growth on culvert components</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• Concrete Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Reinforced Concrete Walls and Top Slab</li> <li>• Concrete Solid Paneled Parapets</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt overlay</li> <li>• Existing non-historic cementitious materials on the face of wingwalls</li> </ul>



# CULVERT INFORMATION

## Significance & Context

### ***Archaeological / Cultural Significance***

The place name *Hanawi* is defined as, “seeking freshwater shellfish. Stream, Koolau. Maui.”<sup>1</sup> The East Hanawi Culvert is adjacent to the East Hanawi Bridge, which spans the East Branch of the Hanawi Stream in Hopenui Ahupuaa.<sup>2</sup>

The Koolau Ditch, an irrigation canal over 40 miles long, runs along the windward side of Haleakala from above Nahiku to the sugar fields of Paia and Puunene. In the Nahiku region, the Koolau Ditch was described in 1915 as crossing through areas rich in field watercress, white ginger, water lemons, and mountain apples. The lands surrounding the village of Nahiku, located directly east of the mouth of the Hanawi Stream, were planted in rubber trees in the early decades of the 1900s.<sup>3</sup>

The Hanawi Stream in Nahiku contained a large fresh water source called Big Spring, which was the subject of a 12-year study conducted by W.O. Clark, the geologist for the Hawaiian Sugar Planters Association, between 1930 and 1942. Geologic studies were carried out at Hanawi Canyon by G.A. MacDonald between 1939 and 1940, during which he succeeded in mapping a number of perched springs and high water tables. The structure of the artesian spring which supplied the large water source was not discovered at that time, but subsequent work by the East Maui Irrigation Company located an artesian source at Hanawi for fresh water 395 feet above sea level.<sup>4</sup>

Refer to Section G, Appendix 1, Section 3.1.2.8 for the regional history of Nahiku, and to Section G, Appendix 1, Figure 10 for nearby archaeological study areas.<sup>5</sup>

### ***Adjacent Cultural Sites***

No documented archaeological sites are currently located within 200 meters of East Hanawi Culvert.

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1 Lorrin Andrews, *A Dictionary of the Hawaiian Language* (Honolulu: The Board of Commissioners of Public Archives of the Territory of Hawaii, 1922).

2 U.S. Geological Survey, ed., *Keanae Quadrangle, Hawaii, 7.5 Minute Series* (United States Department of the Interior, 1992).

3 Alexander Hume Ford, “Around About Nahiku,” *The Mid-Pacific Magazine*, 1915.

4 Territory of Hawaii, *Geology and Ground-Water Resources of the Island of Maui, Hawaii* (Including Haleakala Section, Hawaii National Park), Harold T. Stearns and Gordon A. MacDonald, Bulletin 7 of Division of Hydrography, prepared in cooperation with the Geological Survey, United States Department of the Interior (Honolulu: Advertiser Pub. Co. 1942).

5 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	N/A
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass on downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown



# CULVERT INFORMATION

## Civil & Traffic

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic.

This culvert receives its runoff from a 26-acre (approximate) drainage area and has a terrain that consists of mostly forest type. In addition, the culvert may also receive some runoff from the nearby Hanawi stream in areas where the stream either branches off or over tops. After traveling through the culvert, the runoff eventually makes its way back into the Hanawi Stream. The absolute outlet of the stream is unidentifiable from the highway travel way due to its overgrown nature.

## Structural

East Hanawi Culvert is a one-lane reinforced concrete slab culvert. CRM walls are located at each corner of the approaches to the culvert. The upstream and downstream concrete parapets have a height of 23.5 and 26 inches, respectively. The upstream and downstream parapets are not crash-tested for a TL-2.

The current curb-to-curb dimension is 15.10 feet, which for a one-lane culvert does not meet the design criteria minimum of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of East Hanawi Culvert be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If East Hanawi Culvert is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

The name of this culvert shall be verified through a process to be determined during future development of a PA between the ACHP, SHPD, FHWA, and HDOT, including other concurring parties. Refer to Section G, Appendix 10. Hawaiian Place Names Research for further research and discussion.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

The East Hanawi Culvert currently does not meet the minimum curb-to-curb width of 16 feet for a one-lane culvert; therefore, it is recommended to widen the downstream side of the culvert. Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum. Thickness of the fill on the culvert, between the deck and the asphaltic concrete overlay, shall be limited as shown on the following drawings so as to not affect the height of the new crash-tested railings (refer to "Railings/Parapets" section for more information).

# RECOMMENDATIONS

As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

## **CRM Approach Walls**

This culvert has a CRM approach wall of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance. Approach walls of similar quality are shown in the following bridges and may be used for reference: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

The existing CRM walls at the approaches to the culvert do not meet the TL-2 crash requirements and cannot act as the culvert's traffic features. The existing CRM approach walls are recommended to be replaced with a reinforced concrete wall with a reconstructed rock façade. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The approach walls shall also contain a concrete bridge name panel, pending confirmation of the Hawaiian place name by community and scholarly experts. Refer to Section A, Chapter 5. iii. a. *Approach Walls & Safety Features at the Approaches* for an example of the stone masonry guardwall with bridge name detail.



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, East Hanawi Culvert  
Courtesy of FAI*

To achieve the reconstructed rock façade appearance, the existing CRM façades of the CRM approach walls are to have their rock configurations documented and recorded. Once documentation has been completed, the CRM approach walls are to be carefully disassembled. Thorough documentation of the disassembling rock process is

# RECOMMENDATIONS

highly recommended so as to assist with the later reconstruction of the façades. The original rocks removed from the historic CRM approach walls are to be placed in front of the new reinforced concrete approach walls, functioning as their new façade. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship. The surface of the rock façade shall not exceed 0.5 inches in variation.

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).

The upstream and downstream Hana approach corners have adequate room to curve the approach walls away from the roadway so as to eliminate the potential of a blunt end collision occurring. Bridge #27 East Hanawi Stream Bridge is in close proximity to this culvert; therefore, it is recommended to have the stone masonry guardwall be continuous between the upstream and downstream Kahului parapets.

## ***Railings / Parapets***

The concrete culvert parapets do not meet TL-2 crash requirements. It is recommended to preserve, relocate, and connect the existing downstream parapet to the new widened portion of the deck. A crash-tested railing will be constructed in front of the existing parapets. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to "Deck" section). Also, drainage should be provided through the base of each parapet.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

The CRM wingwalls are recommended to be replaced with a reinforced concrete structure with a reconstructed CRM rock façade. To achieve this, the existing facades of the CRM wingwalls is to have their rock configurations documented and recorded. Once documentation has been completed, the CRM wingwalls is to be carefully disassembled. Thorough documentation of the disassembling rock process is highly recommended so as to assist with the later reconstruction of the façades. The original rocks removed from the historic CRM wingwalls are to be placed in front of the new reinforced concrete wingwalls functioning as their new façade. The appearance of the reconstructed facades shall closely match the shape, proportions, and style as that of the original historic craftsmanship.

It is recommended to investigate the current material composition of the concrete abutments and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert's lifespan.

# RECOMMENDATIONS

Following investigation of concrete abutments and foundations, if it is determined necessary that this component is to be replaced, the abutments and foundations are recommended to replace with a reinforced concrete structure. Until future rehabilitation work is determined, retention of the existing appearance of CRM wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

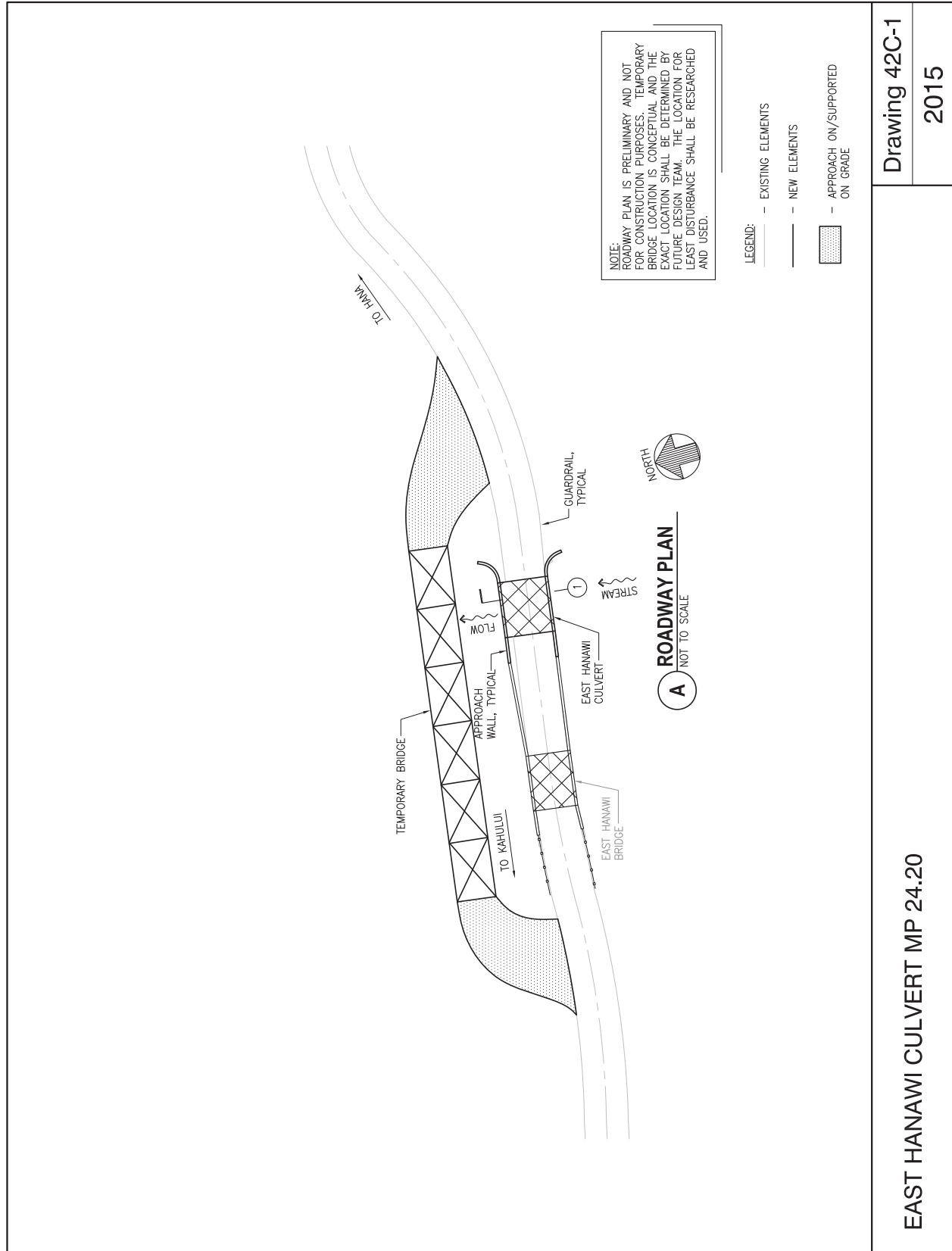
- Add Object Markers to approach walls

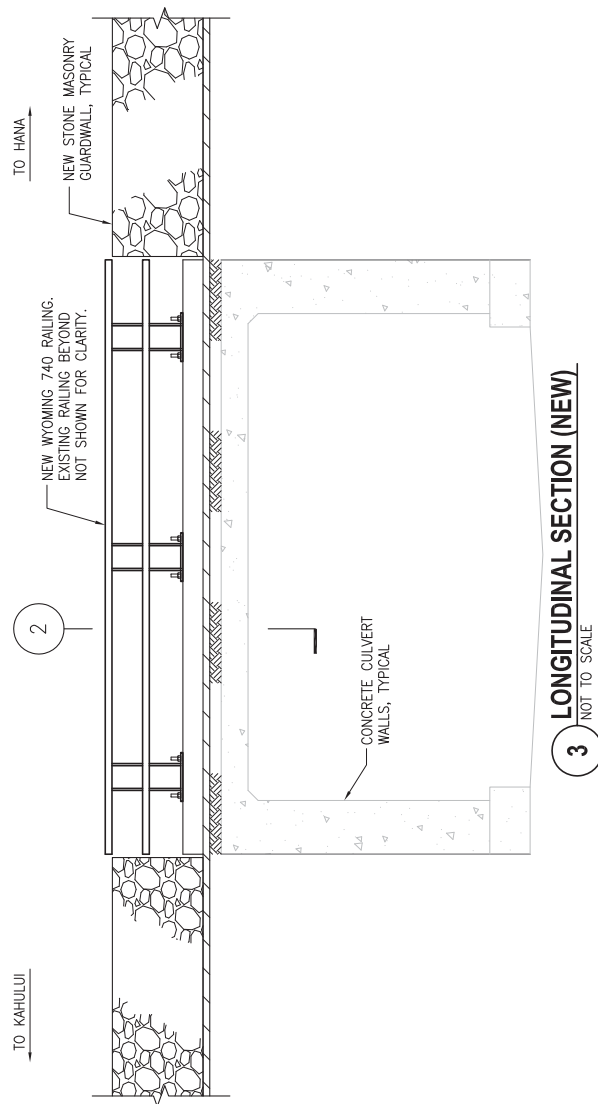
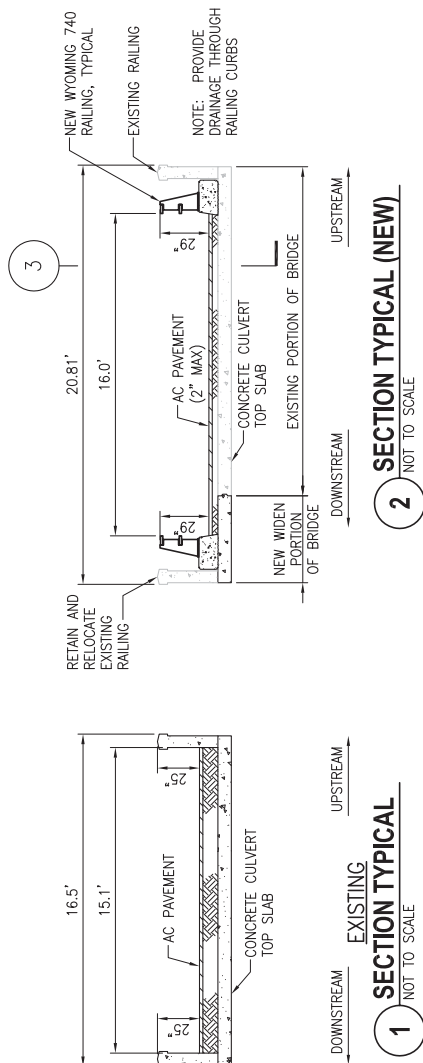
Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for East Hanawi Culvert at this time.

# CURRENT DRAWINGS





\*ALL DIMENSIONS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.

Drawing 42C-2

2015

EAST HANAWI CULVERT MP 24.20

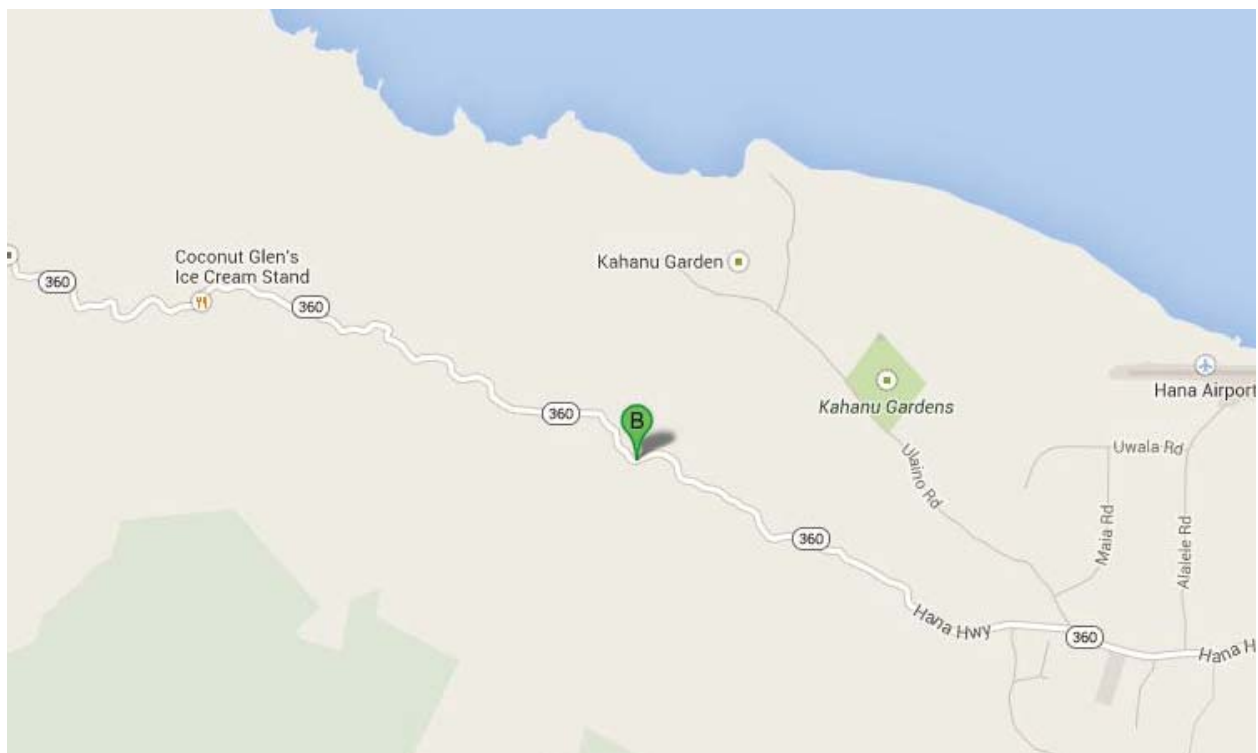
*This page is intentionally left blank.*



Culvert #5 52C



Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 47m 16s
<b>Longitude</b>	156d 02m 17s
<b>Mile Point</b>	29.78

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 16.25 feet (approx)
<b>Number of Spans</b>	1
<b>Clear Span</b>	14.5 feet
<b>Clear Height</b>	10.5 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 14.83 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Open Vertical
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 25 inches</li><li>• Downstream Railing Height = 27 inches</li></ul>
<b>Baluster Dimensions</b>	<ul style="list-style-type: none"><li>• Posts = 6 inches x 6 inches</li><li>• Posts spaced approx. 16 inches on-center</li><li>• End posts = 12 inches x 12 inches</li></ul>
<b>Parapet Cap Profile</b>	<ul style="list-style-type: none"><li>• Rectangular Cap</li><li>• Railing cap = 6 inches x 8 inches</li></ul>

# CULVERT INFORMATION

## Culvert Features

Culvert #5 is located at mile point 29.78 and has a clear opening of approximately 14.5 feet wide by 10.5 feet high. The culvert is 16.25 feet long. The culvert is comprised of a concrete top slab that bears on CRM walls and the invert of the culvert is an unlined channel.



*Concrete open vertical railing, upstream side  
Courtesy of FAI*



*Concrete open vertical railing, downstream side  
Courtesy of FAI*



*CRM abutment, Hana side  
Courtesy of NOEI*



*CRM abutment, Kahului side  
Courtesy of NOEI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	East Honomaele
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Located at open area</li> <li>• Mossy growth on culvert components</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Open Vertical Railings</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> <li>• Existing non-historic cementitious materials on the face of wingwalls</li> </ul>

# CULVERT INFORMATION

## Historic Significance & Context

### ***Archaeological / Cultural Significance***

Culvert #5 is located in East Honomaele Ahupuaa.<sup>1</sup> The place name *Honomaele* is defined as, “Land division, Hana qd., Maui. *Lit.*, numb bay.”<sup>2</sup>

According to Native Hawaiian traditions, around the year A. D. 1570, a high chief from the western side of Maui named Kiha-a-Piilani conquered the formerly independent chiefdoms of the Hana region, uniting the entire island into one *moku*, or polity. At the time of his conquest, Kiha-a-Piilani may have dedicated the massive *heiau* of Piilanihale, which looms above the wind-swept cliffs of Honomaele.<sup>3</sup>

In Native Hawaiian legends, the battles of Kapalipilo describe the assault by the combined forces of Maui, Molokai, and Lanai on the fort at Kauiki that were meant to dislodge the Hawaii forces.<sup>4</sup> According to Kamakau, the field of battle started with the massing of the Maui armies from Heleleikeoha to Nahiku. Wananalua soon became the battlefield. At a signal from the islet of Mokuhanu, the fortified walls of Kauiki were attacked. Soon, the battlefield shifted to the districts of Akiala and Keawaikau. The fighting soon came down to a challenge between Kaohele, a chief from Molokai, and Kamakaukii, a famous fighter from Hawaii. After a time, Kaohele gained the advantage, and Kamakaukii attempted to escape the battlefield, but the Molokai chief chased the Hawaii fighter through the *ahupuaa* of Honomaele to Kawaipapa. Kaohele overtook Kamakaukii at Waialanahu near Pihehe and thrust him through the scrotum with a spear. Despite the victory by Kaohele, the fort did not surrender, Kamehamehanui retired, leaving Hana in the hands of the warriors of Hawaii.<sup>5</sup>

Refer to Section G, Appendix 1, Section 3.1.3.1 for the background history of Honomaele; Section 3.1.3.3.1.6, and Section 3.1.3.3.1.10 for the battle at Kauiki; and to Section G, Appendix 1, Figure 14 for nearby archaeological study areas.<sup>6</sup>

### ***Adjacent Cultural Sites***

No documented archaeological sites are currently located within 200 meters of Culvert #5.

---

1 U.S. Geological Survey, ed., *Hana Quadrangle, Hawaii*, 7.5 Minute Series (United States Department of the Interior, 1992).

2 Mary Kawena Pukui, Samuel H. Elbert, and Esther K. Mookini, *Place Names of Hawaii*, rev. and enl. ed. (Honolulu: University Press of Hawaii, 1974).

3 Patrick V. Kirch, *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory* (Honolulu: University of Hawaii Press, 1985).

4 Abraham Fornander, *An Account of the Polynesian Race, Its Origin and Migrations, Vol. II* (London: Trubner & Co. Ludgate Hill, 1880).

5 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).

6 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).



# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	N/A
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass on downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown



# CULVERT INFORMATION

## **Civil & Traffic**

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic.

This culvert receives its runoff from a 110-acre (approximate) drainage area and has a terrain that consists of mostly forest type. The upstream and downstream ends of the culvert are highly vegetated and overgrown. The absolute outlet of the stream is unidentifiable from the highway travel way.

## **Structural & Electrical**

Culvert #5 is a one-lane reinforced concrete slab culvert. Concrete end walls with metal guardrail transitions are located at each corner of the approaches. The upstream and downstream concrete parapets have a height of 25 inches and 27 inches, respectively. The upstream and downstream parapets are not crash-tested for a TL-2.

The current curb-to-curb dimension is approximately 14.8 feet, which for a one-lane culvert does not meet the design criteria minimum of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #5 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #5 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological intensive survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future Contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

Culvert #5 currently does not meet the minimum curb-to-curb width of 16 feet for a one-lane culvert; therefore, it is recommended to widen the upstream side of the culvert. Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing railings and lowers the height below code minimum.

As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.



*Existing guardrails  
Courtesy of NOEI*

# RECOMMENDATIONS

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

## ***Culvert Approach Walls***

Currently, there are no approach walls at this culvert; therefore, it is recommended to install approach walls at all approach corners. The approach wall will consist of a reinforced concrete wall with a natural rock façade to match the appearance of other culverts along Hana Highway. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The surface of the rock façade shall not exceed 0.5 inches in variation. The approaches do not have adequate room to curve the approach walls away from the roadway as to eliminate the potential of a blunt end collision; therefore, it is recommended to install guardrails and an end treatment at each corner after the stone masonry guardwall.

New approach walls shall be designed to be independent of the culvert railings; a space is recommended between railings and approach walls. A maximum space of 0.5 inches shall be maintained between culvert railings and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. Approach Walls and Safety Features at the Approaches).

## ***Railings / Parapets***

The concrete culvert railings do not meet TL-2 crash requirements. It is recommended to preserve, relocate, and connect the existing upstream railings to the new widened portion of the deck. A crash-tested railing will be constructed in front of the existing railings. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to “Deck” section). Also, drainage should be provided through the base of each railing curb.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

The CRM abutments and wingwalls are recommended to be replaced with a reinforced concrete structure with a reconstructed CRM rock façade. To achieve this, the existing facades of the CRM abutments and wingwalls are to have their rock configurations documented and recorded. Once documentation has been completed, the CRM abutments and wingwalls are to be carefully disassembled. Thorough documentation of the disassembling rock process is highly recommended so as to assist with the later reconstruction of the façades. Reinforced concrete abutments and wingwalls are to be designed and constructed to support the new 40-ton load carrying capacity and comply with current seismic codes (refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information). The original rocks removed from the historic CRM abutments and wingwalls are to be placed in front of the new reinforced concrete abutments and wingwalls, functioning as their new façade. The appearance of the reconstructed facades shall closely match that of the original historic craftsmanship.

# RECOMMENDATIONS

It is recommended to investigate the current condition of the foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. If it is determined necessary to rehabilitate the concrete foundations, it is recommended to be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

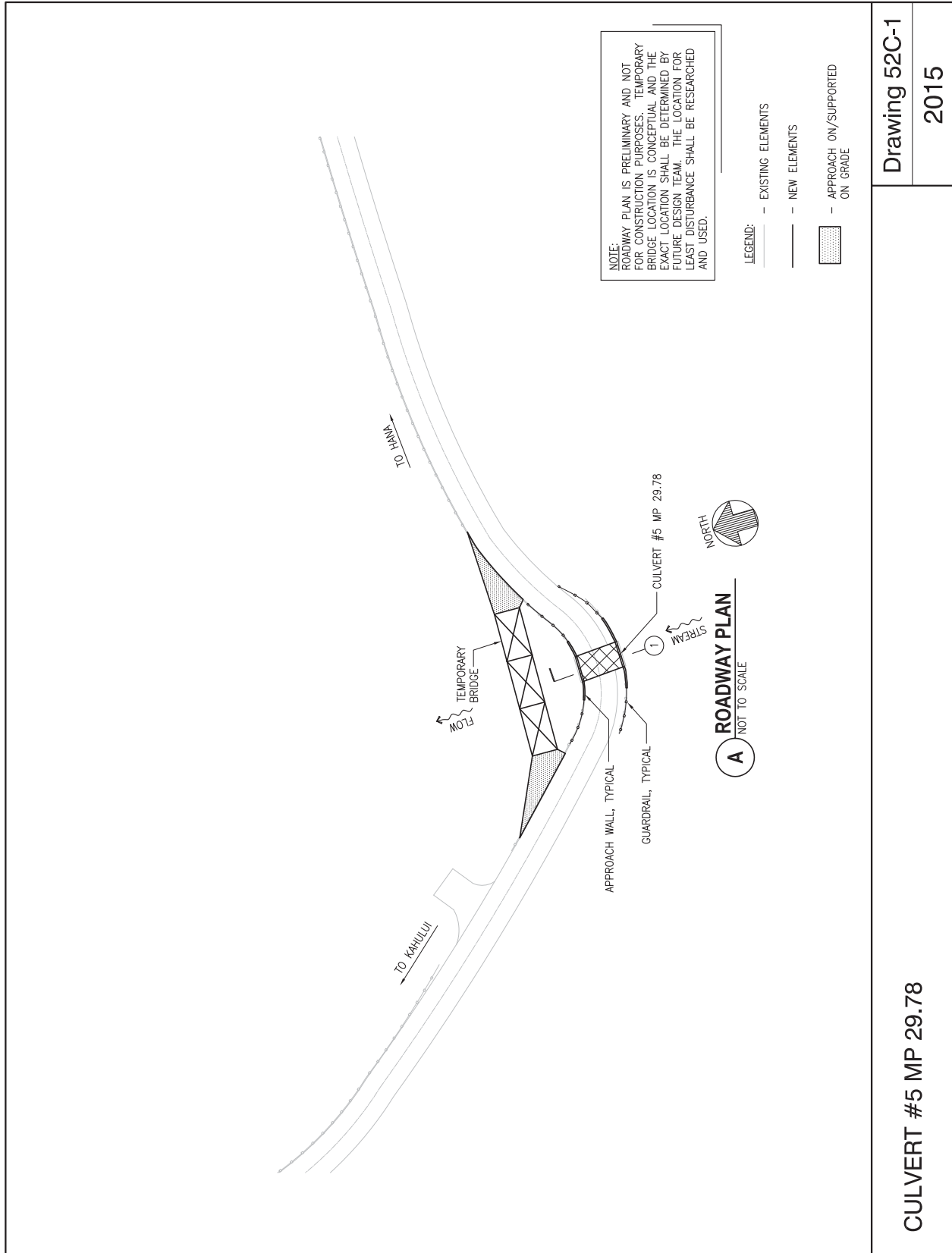
- Add Object Markers to approach walls

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #5 at this time.

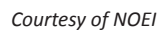
# CURRENT DRAWINGS



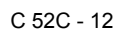
Drawing 52C-1

2015

CULVERT #5 MP 29.78



**2** SECTION TYPICAL (NEW)  
NOT TO SCALE



\*ALL DIMENSIONS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.

Drawing 52C-2

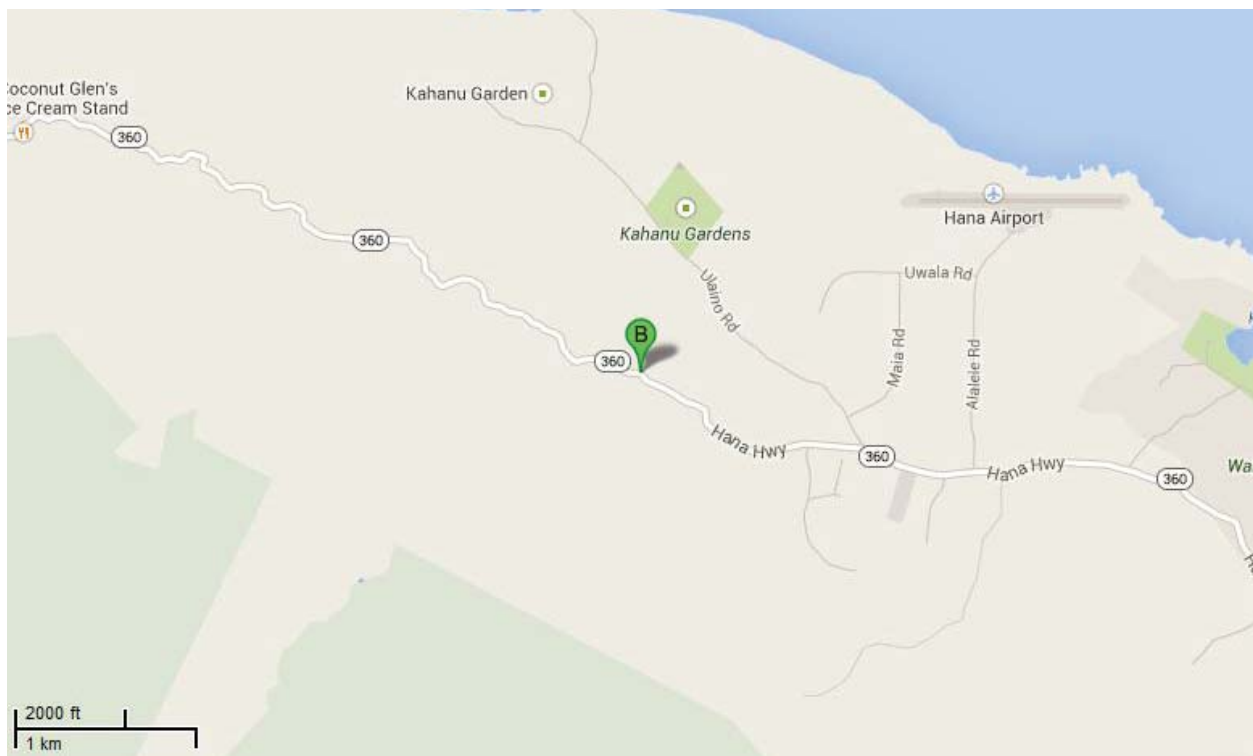
Drawing 52C-2

Culvert #6 53C





Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 47m 13s
<b>Longitude</b>	156d 02m 06s
<b>Mile Point</b>	30.02

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 16.50 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	11.58 feet
<b>Clear Height</b>	7 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 15.08 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Open Vertical Railings
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 25 inches</li><li>• Downstream Railing Height = 25 inches</li></ul>
<b>Baluster Dimensions</b>	<ul style="list-style-type: none"><li>• Posts = 6 inches x 6 inches</li><li>• Posts spaced approx. 16 inches on-center</li><li>• End posts = 12 inches x 12 inches</li></ul>
<b>Parapet Cap Profile</b>	<ul style="list-style-type: none"><li>• Rectangular Cap</li><li>• Railing cap = 6 inches x 8 inches</li></ul>

# CULVERT INFORMATION

## Culvert Features

Culvert #6 is located at mile point 30.02 and has a clear opening of approximately 11.6 feet wide by 7 feet high. The culvert is 16.50 feet long. The culvert is comprised of a concrete top slab that bears on CRM walls and the invert of the culvert is an unlined channel.



*Concrete open vertical railing, downstream side  
Courtesy of NOEI*



*View of Culvert #6 substructure  
Courtesy of NOEI*



*Kahului approach to Culvert #6 toward Hana  
Courtesy of NOEI*



*Hana approach to Culvert #6 toward Kahului  
Courtesy of NOEI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Kawela
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Open Vertical Railings</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>

# CULVERT INFORMATION

## Significance & Context

### ***Archaeological / Cultural Significance***

Culvert #6 is located in Kawela Ahupuaa.<sup>1, 2</sup> The place name *Kawela* is defined as, “Land division, Hana qd., Maui... *Lit.*, the heat.”<sup>3</sup>

According to Native Hawaiian legend, in about 1760 the chief of Hawaii Island, Kalaniopuu, attacked the southern coast of Maui and captured the fort of Kauiki. This attack then made Hana and Kipuhulu a part of his domain. Kalaniopuu appointed Puna, a famous warrior and chief, to be in charge of protecting the fortress of Kauiki. It was soon decided by the chiefs of Maui, Molokai, and Lanai that the fortress should be in the hands of Kamehameha-nui, the ruler of Maui. This war was long, and involved widespread warfare primarily in the *ahupuaa* of Honomalee, Kawela, both Kuukuukamanu, both Kahalili, two Kaeleku, Honokalani, Wakiu and part of Kawaipapa.<sup>4</sup>

Refer to Section G, Appendix 1, Section 3.1.3.3.1.10 for the battle at Kauiki; and to Section G, Appendix 1, Figure 14 for nearby archaeological study areas.

### ***Adjacent Cultural Sites***

No documented archaeological sites are currently located within 200 meters of Culvert #6.

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1 U.S. Geological Survey, ed., *Hana Quadrangle, Hawaii*, 7.5 Minute Series (United States Department of the Interior, 1992).

2 F. S. Dodge, “Maui, Hawaiian Islands,” Library of Congress Geography and Map Division Washington, D.C. 20540-4650: Hawaiian Government Survey (Washington, D.C.: 1885).

3 Mary Kawena Pukui, Samuel H. Elbert, and Esther K. Mookini, *Place Names of Hawaii*, rev. and enl. ed. (Honolulu: University Press of Hawaii, 1974).

4 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).



# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass upstream side
<b>Electrical Utilities</b>	An existing telephone pole is in conflict with the temporary bridge
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic.

This culvert receives its runoff from a 200-acre (approximate) drainage area and has a terrain that consists of mostly forest type. The upstream and downstream ends of the culvert are highly vegetated and overgrown. The absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Culvert #6 is a one-lane reinforced concrete slab culvert. Concrete end walls with metal guardrail transitions are located at each corner of the approaches. The upstream and downstream concrete railings have a height of 25 inches. The upstream and downstream railings are not crash-tested for a TL-2.

The current curb-to-curb dimension is 15.08 feet, which for a one-lane culvert does not meet the design criteria minimum of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #6 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #6 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. . The future Contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per bridge component, as follows:*

### **Deck**

Culvert #6 currently does not meet the minimum curb-to-curb width of 16 feet for a one-lane culvert; therefore, it is recommended to widen the upstream side of the culvert. Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum.

As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.



# RECOMMENDATIONS

## ***CRM Approach Walls***

Currently, there are no approach walls at this culvert; therefore, it is recommended to install approach walls at all approach corners. The approach wall will consist of a reinforced concrete wall with a natural rock façade to match the appearance of other culverts along Hana Highway. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The surface of the rock façade shall not exceed 0.5 inches in variation. The approaches do not have adequate room to curve the approach walls away from the roadway as to eliminate the potential of a blunt end collision; therefore, it is recommended to install guardrails and an end treatment at each corner after the stone masonry guardwall.

New approach walls shall be designed to be independent of the culvert railings; a space is recommended between railings and approach walls. A maximum space of 0.5 inches shall be maintained between culvert railings and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).

## ***Railings / Parapets***

The concrete culvert railings do not meet TL-2 crash requirements. It is recommended to preserve, relocate, and connect the existing upstream railings to the new widened portion of the deck. A crash-tested railing will be constructed in front of the existing railings. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to “Deck” section). Also, drainage should be provided through the base of each railing curb.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

The CRM culvert walls and CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current condition of the foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. If it is determined necessary to rehabilitate the concrete foundations, it is recommended to be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. It is recommended to investigate the current condition of the foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver's visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

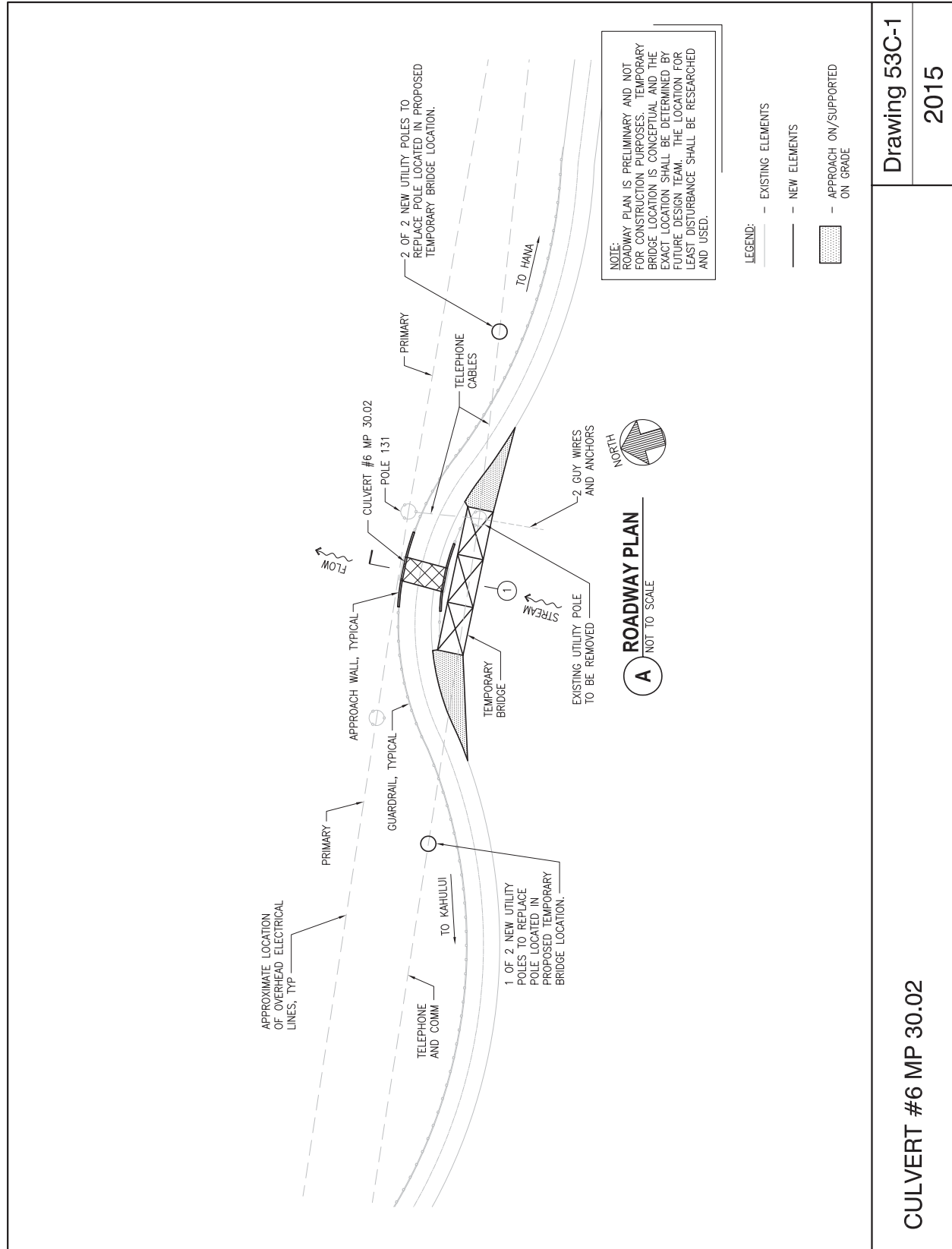
- Add Object Markers to approach walls

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

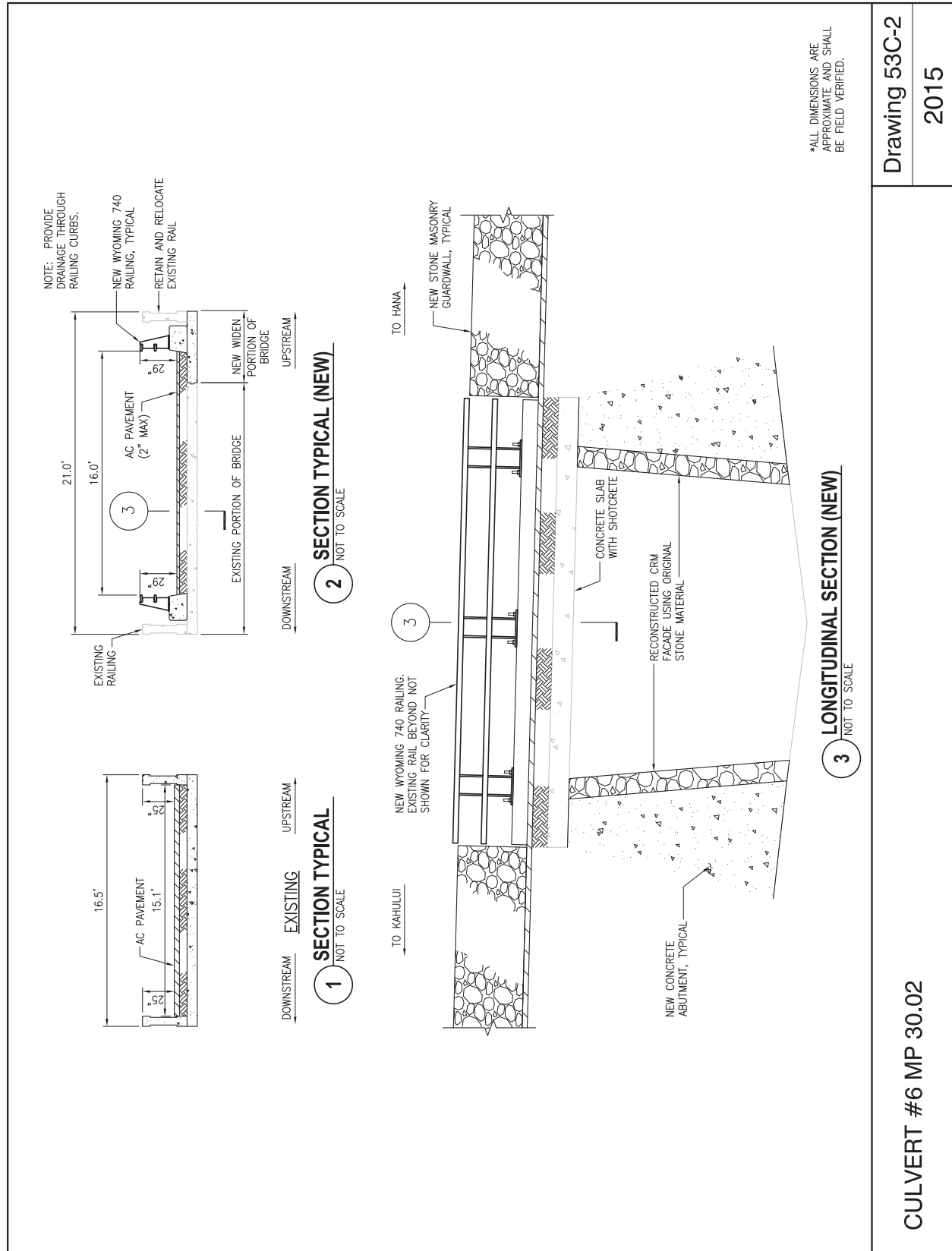
## ***Electrical***

An existing telephone pole is in conflict with the temporary bridge. The existing telephone pole should be replaced with two new telephone poles that will allow the existing span to remain. The telephone lines are over the area of work but the contractor can coordinate work with the utility companies and take steps to ensure the safety of the crew and that existing utilities are not disturbed. The temporary bridge can pass underneath the existing overhead electrical lines but the contractor should verify with Hawaiian Telcom that the overhead clearance meets vehicle traffic requirements.

# CURRENT DRAWINGS



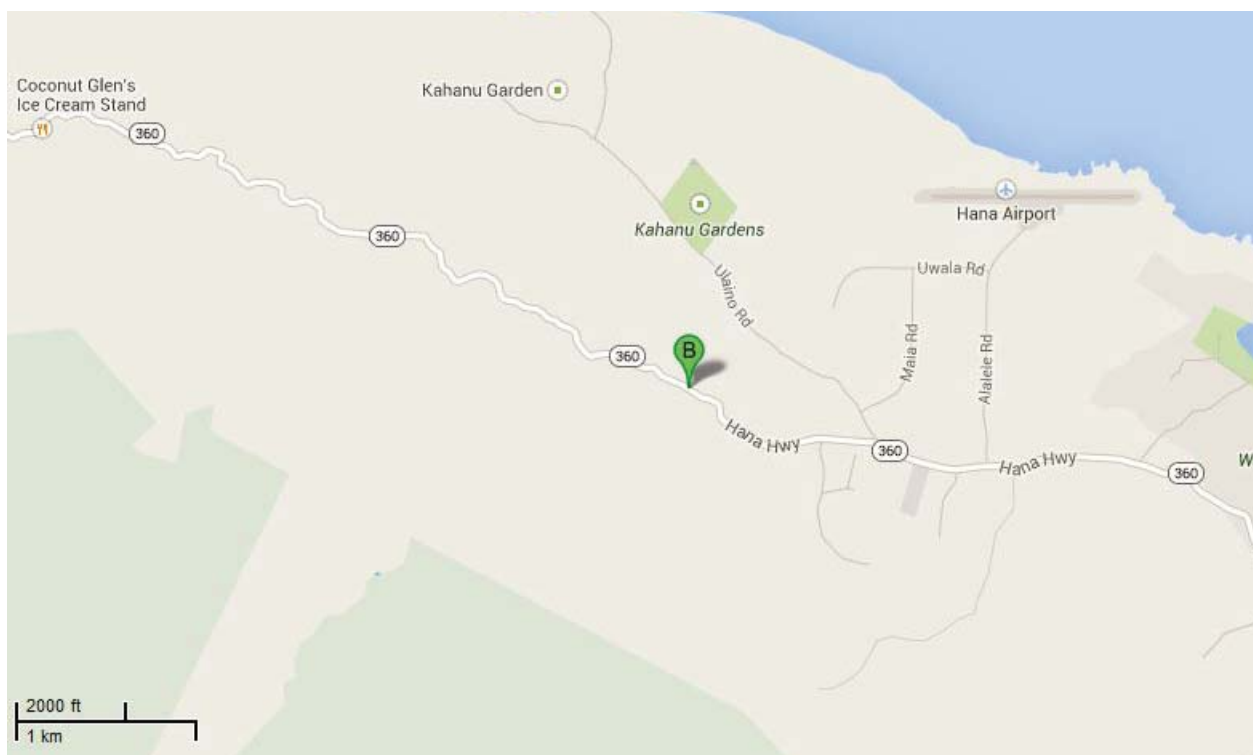
Drawing 53C-1	
2015	CULVERT #6 MP 30.02



Culvert #7 54C



Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 47m 11s
<b>Longitude</b>	156d 02m 00s
<b>Mile Point</b>	30.13

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 15.66 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	5.33 feet
<b>Clear Height</b>	5.5 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 14.58 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Open Vertical
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 27 inches</li><li>• Downstream Railing Height = 29 inches</li></ul>
<b>Baluster Dimensions</b>	<ul style="list-style-type: none"><li>• Posts = 6 inches x 6 inches</li><li>• Posts spaced approx. 16 inches on-center</li><li>• End posts = 12 inches x 12 inches</li></ul>
<b>Parapet Cap Profile</b>	<ul style="list-style-type: none"><li>• Rectangular Cap</li><li>• Railing cap = 6 inches x 8 inches</li></ul>



# CULVERT INFORMATION

## Culvert Features

Culvert #7 is located at mile point 30.13 and has a clear opening of approximately 5.3 feet wide by 5.5 feet high. The culvert is 15.66 feet long. The culvert is comprised of a concrete top slab that bears on CRM walls and the invert of the culvert is an unlined channel.



*Concrete open railings with inset panels at end caps, downstream side  
Courtesy of NOEI*



*CRM abutments  
Courtesy of NOEI*



*Hana approach to Culvert #7 toward Kahului  
Courtesy of NOEI*



*Kahului approach to Culvert #7 toward Hana  
Courtesy of NOEI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Kawela
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Open Vertical Railings</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>

# CULVERT INFORMATION

## Significance & Context

### ***Archaeological / Cultural Significance***

Culvert #7 is located in Kawela Ahupuaa.<sup>1, 2</sup> The place name *Kawela* is defined as, “Land division, Hana qd., Maui... *Lit.*, the heat.”<sup>3</sup>

According to Native Hawaiian legend, in about 1760 the chief of Hawaii Island, Kalaniopuu, attacked the southern coast of Maui and captured the fort of Kauiki. This attack then made Hana and Kipuhulu a part of his domain. Kalaniopuu appointed Puna, a famous warrior and chief, to be in charge of protecting the fortress of Kauiki. It was soon decided by the chiefs of Maui, Molokai, and Lanai that the fortress should be in the hands of Kamehameha-nui, the ruler of Maui. This war was long, and involved widespread warfare primarily in the *ahupuaa* of Honomalee, Kawela, both Kuukuukamanu, both Kahalili, two Kaeleku, Honokalani, Wakiu and part of Kawaipapa.<sup>4</sup>

Refer to Section G, Appendix 1, Section 3.1.3.3.1.10 for the battle at Kauiki; and to Section G, Appendix 1, Figure 14 for nearby archaeological study areas.<sup>5</sup>

### ***Adjacent Cultural Sites***

No documented archaeological sites are located within 200 meters of Culvert #7.

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1 U.S. Geological Survey, ed., *Hana Quadrangle, Hawaii*, 7.5 Minute Series (United States Department of the Interior, 1992).

2 F. S. Dodge, “Maui, Hawaiian Islands,” Library of Congress Geography and Map Division Washington, D.C. 20540-4650: Hawaiian Government Survey (Washington, D.C.: 1885).

3 Mary Kawena Pukui, Samuel H. Elbert, and Esther K. Mookini, *Place Names of Hawaii*, rev. and enl. ed. (Honolulu: University Press of Hawaii, 1974).

4 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).

5 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic.

This culvert receives its runoff from a 72-acre (approximate) drainage area and has a terrain that consists of mostly forest type. The upstream and downstream ends of the culvert are highly vegetated and overgrown. The absolute outlet of the stream is unidentifiable from the highway travel way.

## Structural

Culvert #7 is a one-lane reinforced concrete slab culvert. Concrete end walls with metal guardrail transitions are located at each corner of the approaches. The upstream and downstream concrete railings have a height of 27 inches and 29 inches, respectively. The upstream and downstream railings are not crash-tested for a TL-2.

The current curb-to-curb dimension is 14.58 feet, which for a one-lane culvert does not meet the design criteria minimum of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #7 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #7 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future Contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per bridge component, as follows:*

### **Deck**

Culvert #7 currently does not meet the minimum curb-to-curb width of 16 feet for a one-lane culvert; therefore, it is recommended to widen the upstream side of the culvert. Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum.

As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

# RECOMMENDATIONS

## ***CRM Approach Walls***

Currently, there are no approach walls at this culvert; therefore, it is recommended to install approach walls at all approach corners. The approach wall will consist of a reinforced concrete wall with a natural rock façade to match the appearance of other culverts along Hana Highway. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The surface of the rock façade shall not exceed 0.5 inches in variation. The approaches do not have adequate room to curve the approach walls away from the roadway as to eliminate the potential of a blunt end collision; therefore, it is recommended to install guardrails and an end treatment at each corner after the stone masonry guardwall.

New approach walls shall be designed to be independent of the culvert railings; a space is recommended between railings and approach walls. A maximum space of 0.5 inches shall be maintained between culvert railings and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. Approach Walls and Safety Features at the Approaches).

## ***Railings / Parapets***

The concrete culvert railings do not meet TL-2 crash requirements. It is recommended to preserve, relocate, and connect the existing upstream railings to the new widened portion of the deck. A crash-tested railing will be constructed in front of the existing railings. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to “Deck” section). Also, drainage should be provided through the base of each railing curb.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

The CRM culvert walls and CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current condition of the foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. If it is determined necessary to rehabilitate the concrete foundations, it is recommended to be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver's visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

- Add Object Markers to approach walls

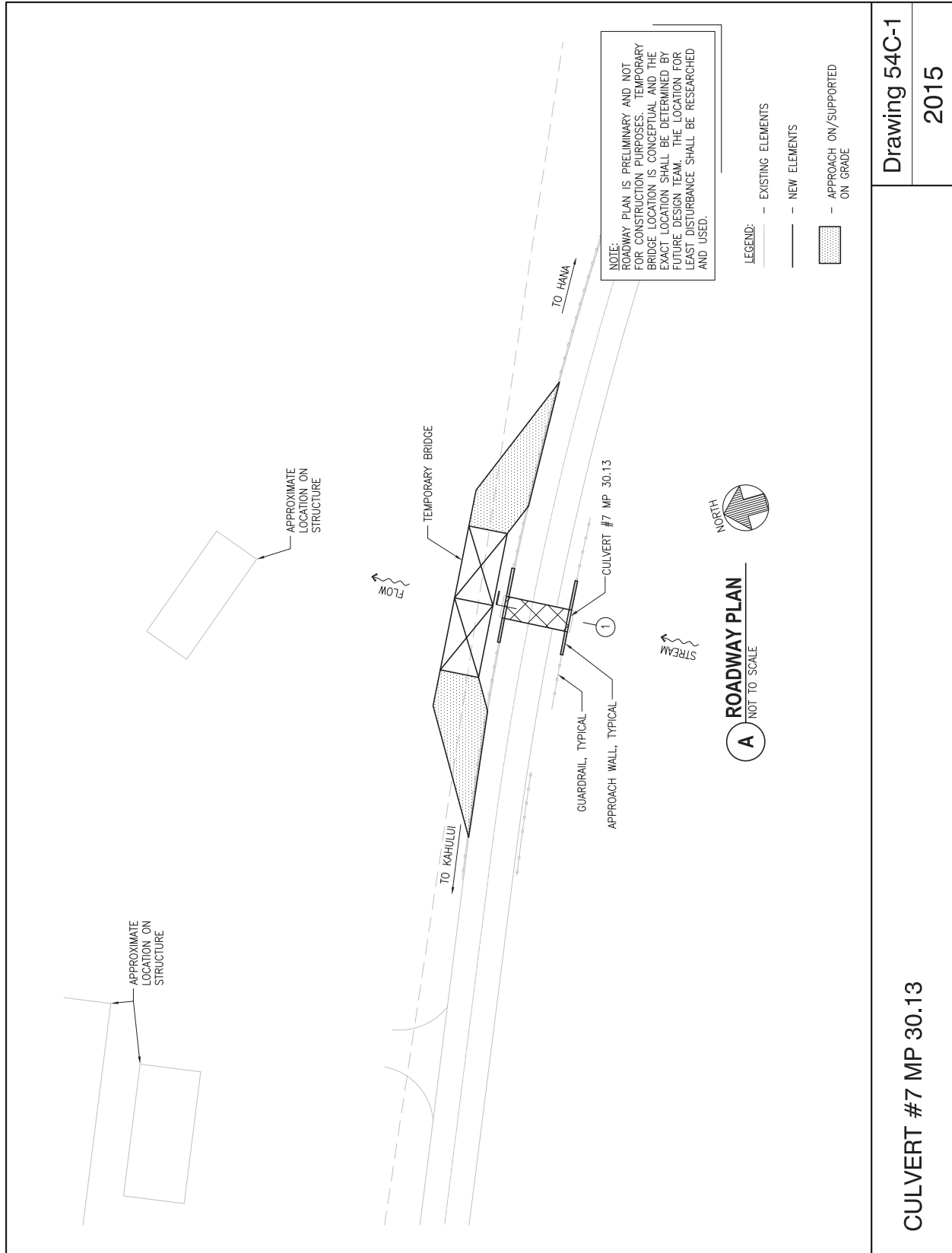
Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

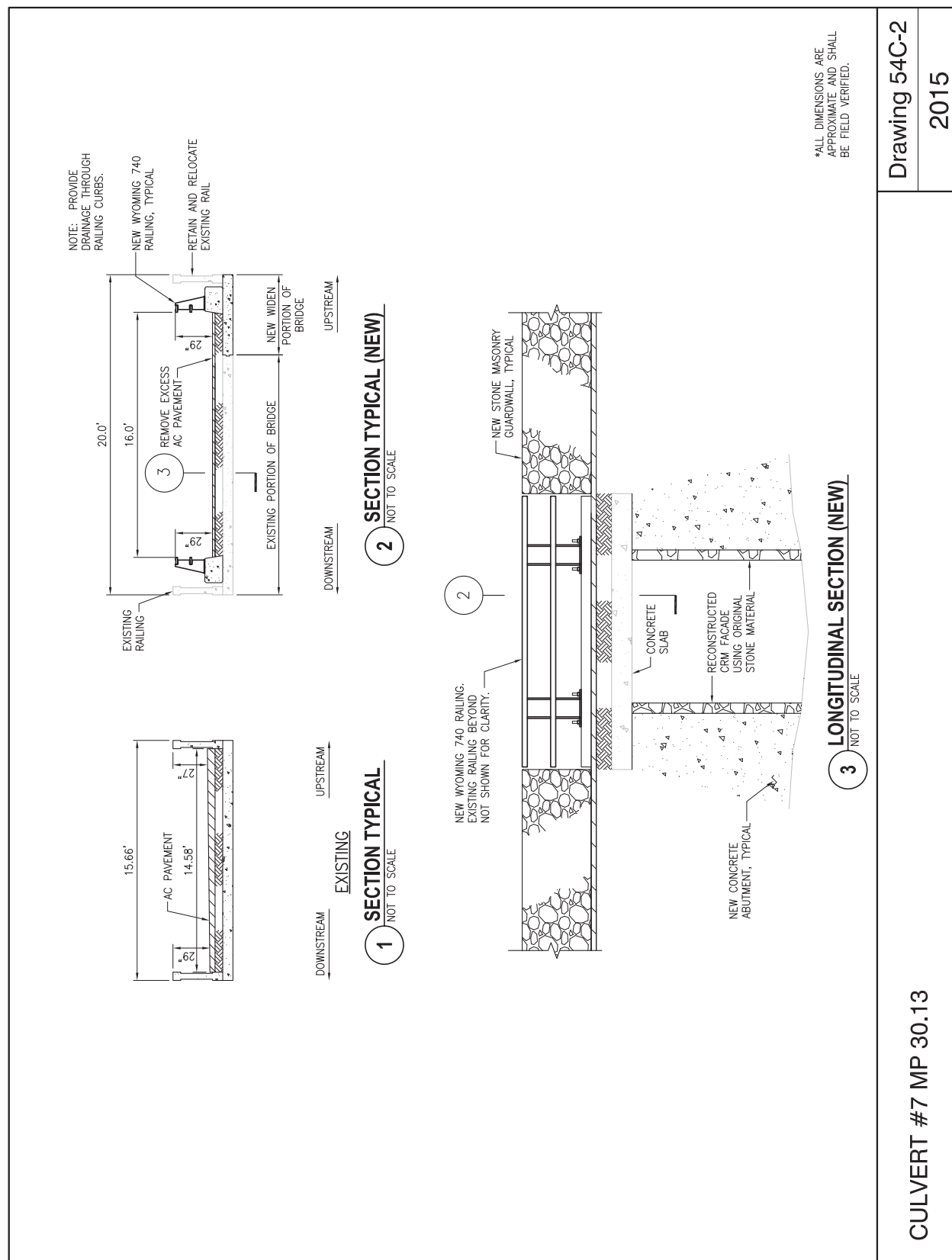
Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #7 at this time.



# CURRENT DRAWINGS



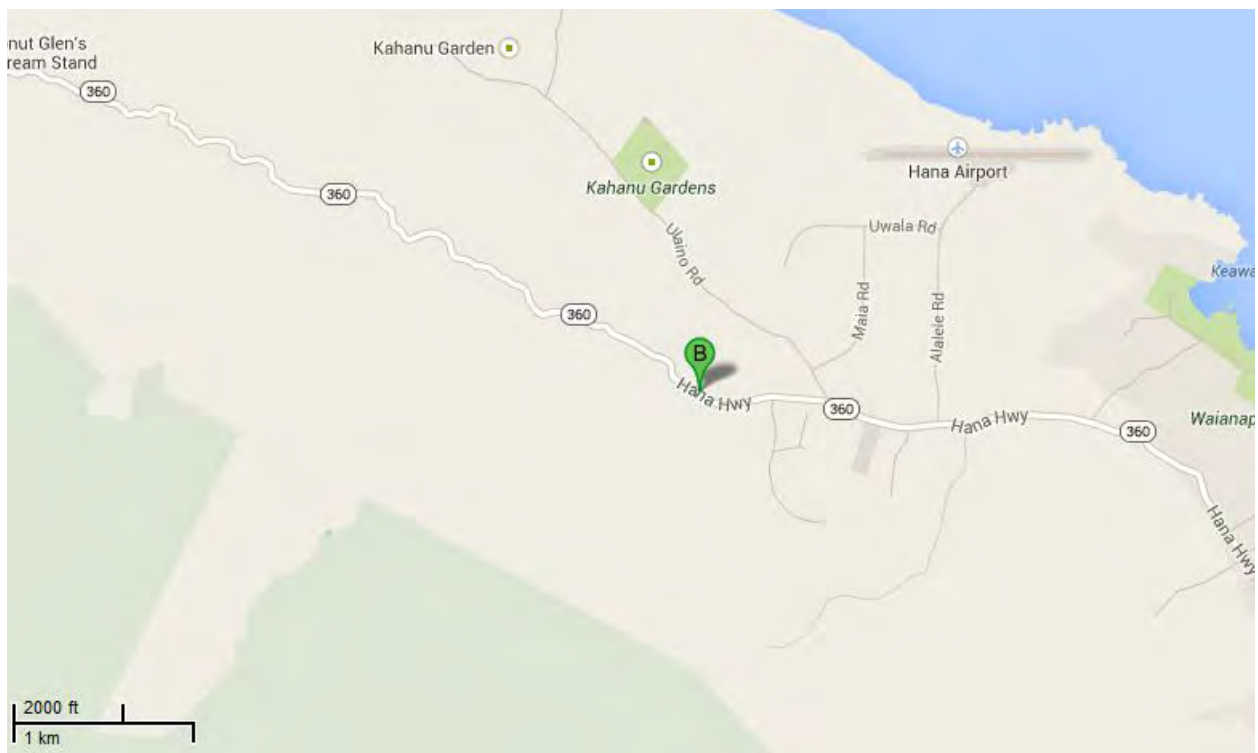
Drawing 54C-1	
2015	CULVERT #7 MP 30.13



Culvert #8 55C



Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 47m 02s
<b>Longitude</b>	156d 01m 47s
<b>Mile Point</b>	30.44

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 16.25 feet (approx)
<b>Number of Spans</b>	1
<b>Clear Span</b>	11.5 feet
<b>Clear Height</b>	8.67 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 15.08 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• CRM Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Open Vertical
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 25 inches</li><li>• Downstream Railing Height = 25 inches</li></ul>
<b>Baluster Dimensions</b>	<ul style="list-style-type: none"><li>• Posts = 6 inches x 6 inches</li><li>• Posts spaced approx. 16 inches on-center</li><li>• End posts = 12 inches x 12 inches</li></ul>
<b>Parapet Cap Profile</b>	<ul style="list-style-type: none"><li>• Rectangular Cap</li><li>• Railing cap = 6 inches x 8 inches</li></ul>



# CULVERT INFORMATION

## Culvert Features

Culvert #8 is located at mile point 30.44 and has a clear opening of approximately 11.5 feet wide by 8.7 feet high. The culvert is 16.25 feet long. The culvert is comprised of a concrete top slab that bears on CRM walls and the invert of the culvert is an unlined channel.



*Concrete open vertical railing, upstream side  
Courtesy of NOEI*



*Concrete open vertical railing, downstream side  
Courtesy of NOEI*



*Hana approach to Culvert #8 toward Kahului  
Courtesy of NOEI*



*Kahului approach to Culvert #8 toward Hana  
Courtesy of NOEI*

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Kawela
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• CRM Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Open Vertical Railings</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>



# CULVERT INFORMATION

## Significance & Context

### ***Archaeological / Cultural Significance***

Culvert #8 is located in Kawela Ahupuaa.<sup>1, 2</sup> The place name *Kawela* is defined as, “Land division, Hana qd., Maui... *Lit.*, the heat.”<sup>3</sup>

According to Native Hawaiian legend, in about 1760 the chief of Hawaii Island, Kalaniopuu, attacked the southern coast of Maui and captured the fort of Kauiki. This attack then made Hana and Kipuhulu a part of his domain. Kalaniopuu appointed Puna, a famous warrior and chief, to be in charge of protecting the fortress of Kauiki. It was soon decided by the chiefs of Maui, Molokai, and Lanai that the fortress should be in the hands of Kamehameha-nui, the ruler of Maui. This war was long, and involved widespread warfare primarily in the *ahupuaa* of Honomalee, Kawela, both Kuukuukamanu, both Kahalili, two Kaeleku, Honokalani, Wakiu and part of Kawaipapa.<sup>4</sup>

Refer to Section G, Appendix 1, Section 3.1.3.3.1.10 for the battle at Kauiki; and to Section G, Appendix 1, Figure 14 for nearby archaeological study areas.<sup>5, 6</sup>

### ***Adjacent Cultural Sites***

No documented archaeological sites are located within 200 meters of Culvert #8.

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1 U.S. Geological Survey, ed., *Hana Quadrangle, Hawaii*, 7.5 Minute Series (United States Department of the Interior, 1992).

2 F. S. Dodge, “Maui, Hawaiian Islands,” Library of Congress Geography and Map Division Washington, D.C. 20540-4650: Hawaiian Government Survey (Washington, D.C.: 1885).

3 Mary Kawena Pukui, Samuel H. Elbert, and Esther K. Mookini, *Place Names of Hawaii*, rev. and enl. ed. (Honolulu: University Press of Hawaii, 1974).

4 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).

5 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

6 K. W. Bushnell and Hallett H. Hammatt, “Archaeological Inventory Survey of the 34 Acre Perma Property, Hana, Kawela Ahupua’a, Maui (TMK 1-3-03:15),” inventory survey, Cultural Surveys Hawai’i, Inc. (2000).

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	None
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	An existing telephone pole is adjacent to the temporary bridge
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## **Civil & Traffic**

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic.

This culvert receives its runoff from an 8.5-acre (approximate) drainage area and has a terrain that consists of mostly forest type. The upstream and downstream ends of the culvert are highly vegetated and overgrown. The absolute outlet of the stream is unidentifiable from the highway travel way.

## **Structural**

Culvert #8 is a one-lane reinforced concrete slab culvert. Concrete end walls with metal guardrail transitions are located at each corner of the approaches. The upstream and downstream concrete railings have a height of 25 inches. The upstream and downstream railings are not crash-tested for a TL-2.

The current curb-to-curb dimension is 15.08 feet, which for a one-lane culvert does not meet the design criteria minimum of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #8 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #8 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future Contractor shall be responsible for providing and maintaining the temporary bridge during the course of the bridge rehabilitation.

*Recommendations have been identified per bridge component, as follows:*

### **Deck**

Culvert #8 currently does not meet the minimum curb-to-curb width of 16 feet for a one-lane bridge; therefore, it is recommended to widen the upstream side of the culvert. Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum.

As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the bridges.

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

# RECOMMENDATIONS

## **CRM Approach Walls**

Currently, there are no approach walls at this culvert; therefore, it is recommended to install approach walls at all approach corners. The approach wall will consist of a reinforced concrete wall with a natural rock façade to match the appearance of other bridges along Hana Highway. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). The approaches do not have adequate room to curve the approach walls away from the roadway as to eliminate the potential of a blunt end collision; therefore, it is recommended to install guardrails and an end treatment at each corner after the stone masonry guardwall.

New approach walls shall be designed to be independent of the bridge railings; a space is recommended between railings and approach walls. A maximum space of 0.5 inches shall be maintained between bridge railings and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

## **Railings / Parapets**

The concrete culvert railings do not meet TL-2 crash requirements. It is recommended to preserve, relocate, and connect the existing upstream railings to the new widened portion of the deck. A crash-tested railing will be constructed in front of the existing railings. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to “Deck” section above). Also, drainage should be provided through the base of each railing curb.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

# RECOMMENDATIONS

## ***Foundations, Wingwalls, & Abutments***

The CRM culvert walls and CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current condition of the foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. If it is determined necessary to rehabilitate the concrete foundations, it is recommended to be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM culvert walls and wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the bridge is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the bridge shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be made compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

- Add Object Markers to approach walls

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

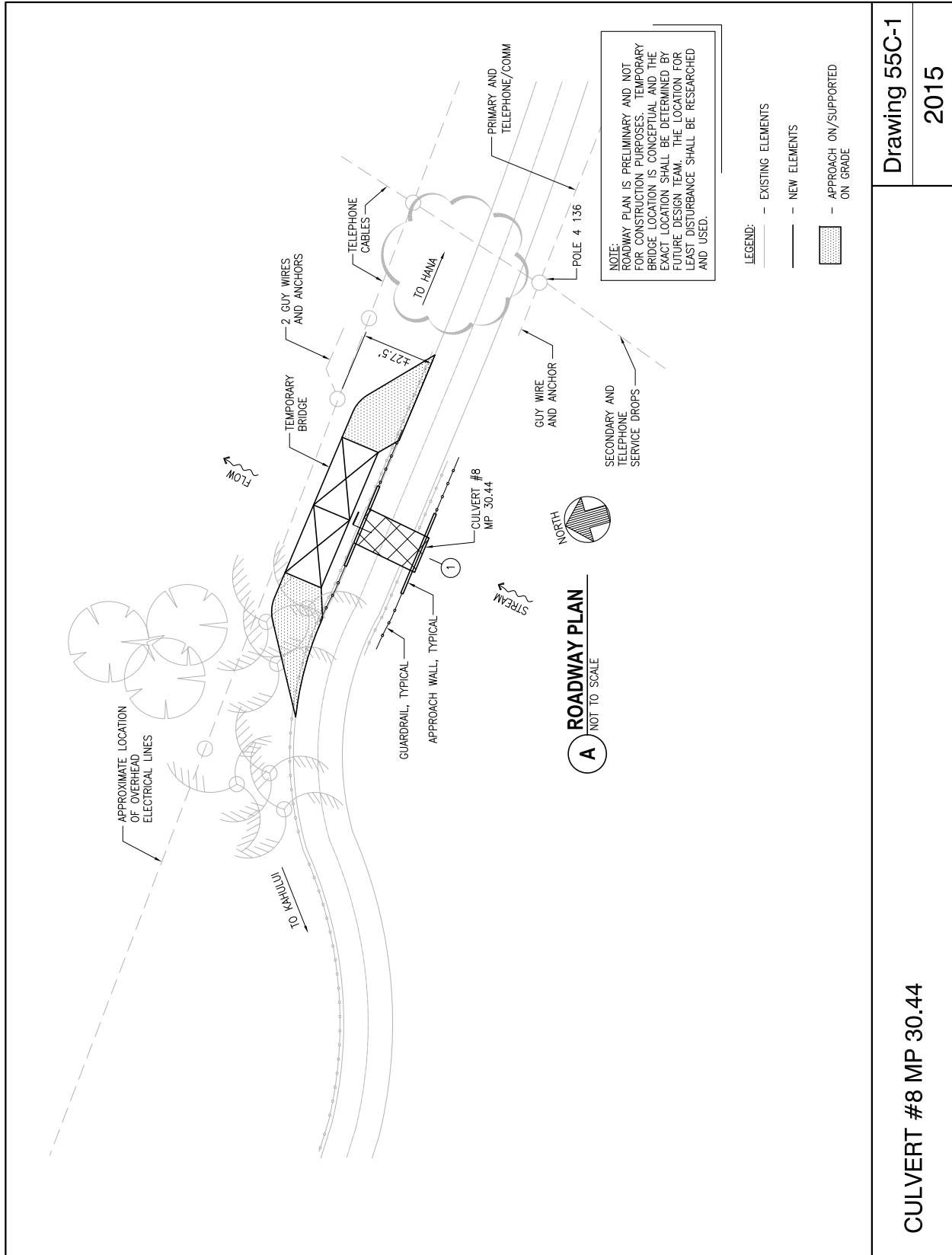


# RECOMMENDATIONS

## ***Electrical***

An existing telephone pole is immediately adjacent to the proposed temporary bridge. The existing telephone pole should be replaced with two new telephone poles that will allow the existing span to remain. The existing telephone lines are to the side of the area of work but the contractor can coordinate work with the utility companies and take steps to ensure the safety of the crew and that existing utilities are not disturbed. The temporary bridge can pass underneath the existing overhead electrical lines but the contractor should verify with Hawaiian Telcom that the overhead clearance meets vehicle traffic requirements (refer to figures below).



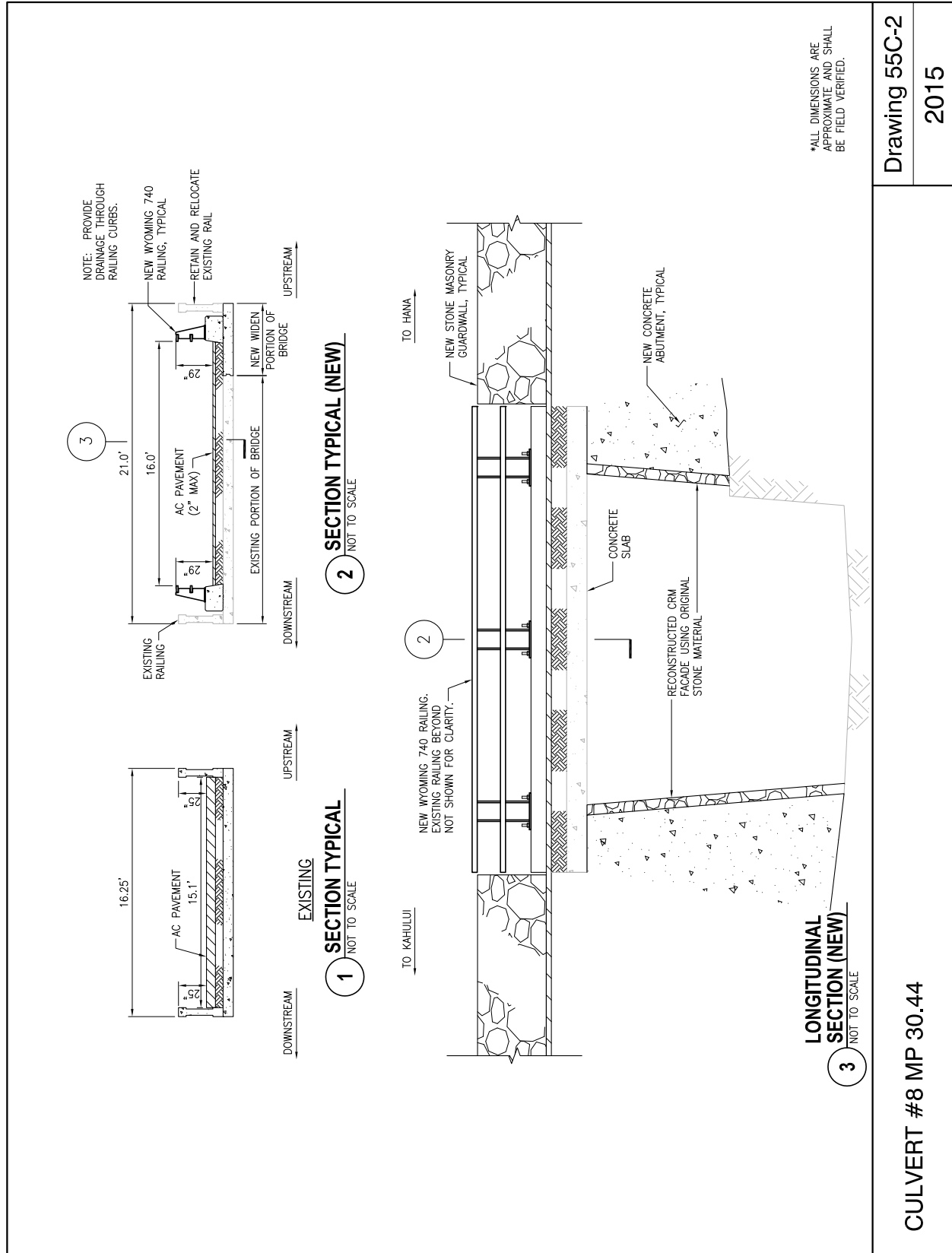


**CULVERT #8 MP 30.44**

**Drawing 55C-1**

**2015**





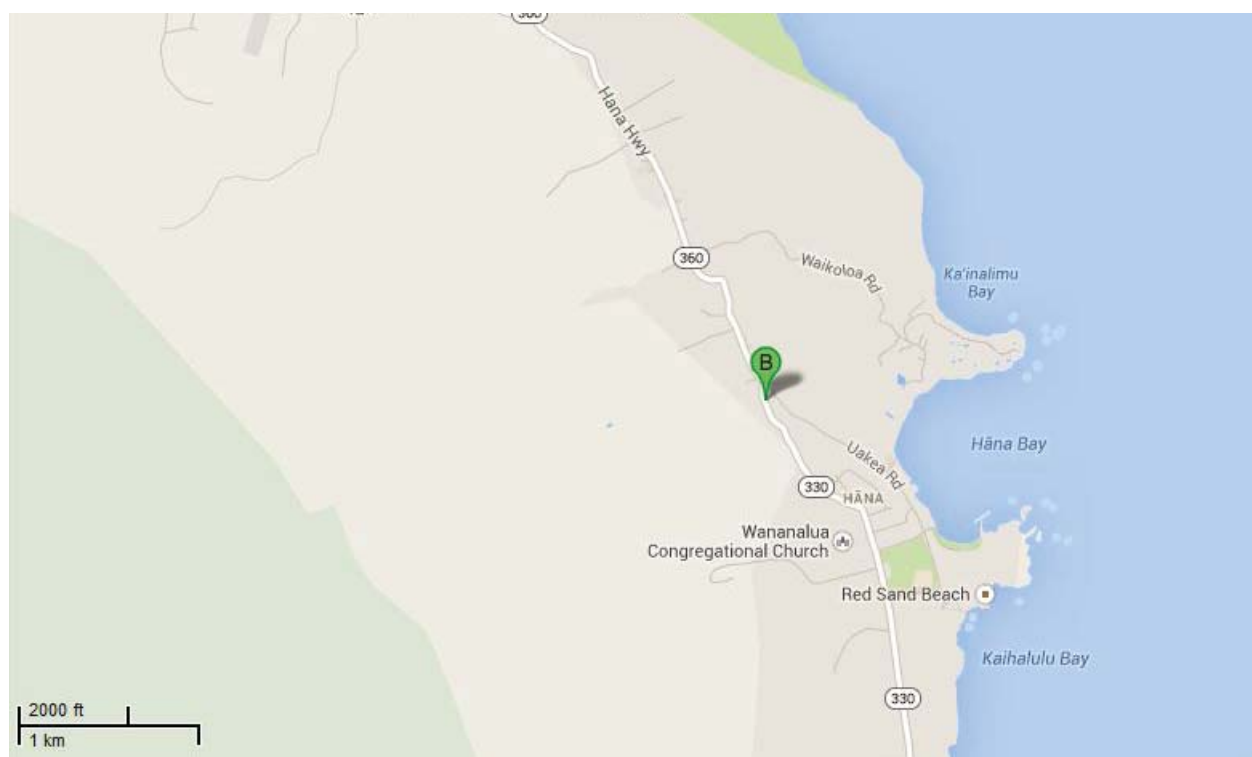
CULVERT #8 MP 30.44		Drawing 55C-2
		2015

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Culvert #9 56C



<b>Culvert Number</b>					<b>Island</b>	Maui
<b>Date of Construction</b>	1915				<b>Route</b>	Hana Highway
<b>Treatment Recommendation</b>	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 45m 44s
<b>Longitude</b>	155d 59m 38s
<b>Mile Point</b>	33.65

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 28.16 feet (approx)
<b>Number of Spans</b>	1
<b>Clear Span</b>	Varies between 14.08 feet (upstream) & 23 feet (downstream)
<b>Clear Height</b>	5.42 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 26.30 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• Concrete Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Concrete Solid Parapets (downstream side was replaced in 2014)
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 27 inches</li><li>• Downstream Railing Height = 30 inches</li></ul>
<b>Parapet Profile</b>	<ul style="list-style-type: none"><li>• Saddle Coping Cap</li><li>• Railing cap = 6 inches x 8 inches</li><li>• Flat Parapet</li></ul>
<b>Parapet Inscription</b>	<ul style="list-style-type: none"><li>• Original: "1915" on downstream face (based on HAER HI-75 report), no longer extant</li><li>• Current: "Holoina wa wae Gulch 1951" with diacritical marks on upstream face (replacement inscription during 2014 rehabilitation project)</li></ul>



# CULVERT INFORMATION

## Culvert Features

Culvert #9 is located at mile point 33.65 in Hana. The culvert measures 28.2 feet in length and has an upstream clear span of 14.1 feet and a downstream clear span of 23 feet. According to the HAER report,<sup>1</sup> the original date of construction is 1915. Record drawings<sup>2</sup> show that the culvert underwent improvements in 2014 to widen the culvert on the downstream side; a site visit on June 26, 2014 confirmed that the improvements were still underway. A site visit in early 2015 confirmed the completion of the improvement work. The top slab and walls are concrete and the bottom is an unlined channel.



*Culvert #9 downstream elevation  
Courtesy of NOEI*



*Concrete abutment, Hana side  
Courtesy of NOEI*



*Kahului approach to Culvert #9 toward Hana, during construction  
Courtesy of NOEI*



*Solid concrete parapet, downstream side, and approach wall  
Courtesy of NOEI*

1 "Hana Belt Road," Historic American Engineering Record, HAER HI-75 (2005).

2 State of Hawaii, Department of Transportation, Highways Division, "Plans for Route 360 Hana Highway Improvements, Uakea Road to Keawe Place," Project No. 360B-01-03 (December 2011).

# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Niumalu
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	2014 widening, downstream parapet replaced; downstream CRM approach wall extended, Hana side
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	<ul style="list-style-type: none"> <li>• Three adjacent archaeological sites, see detailed culvert description for further information</li> </ul>
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Nearby structures</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• Concrete Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Historic upstream solid concrete parapet</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Incorrect parapet inscription on upstream face</li> </ul>



# CULVERT INFORMATION

## Significance & Context

### *Archaeological / Cultural Significance*

Culvert #9 is located along Hana Highway, Route 330, just south of the junctions with Hana Highway, Route 360. The culvert lies in Niumalu Ahupuaa.<sup>3</sup> The place name *Niumalu* is defined as, “Land sections, Kau-po and Hana qds... *Lit.*, shade [of] coconut trees.”<sup>4</sup>

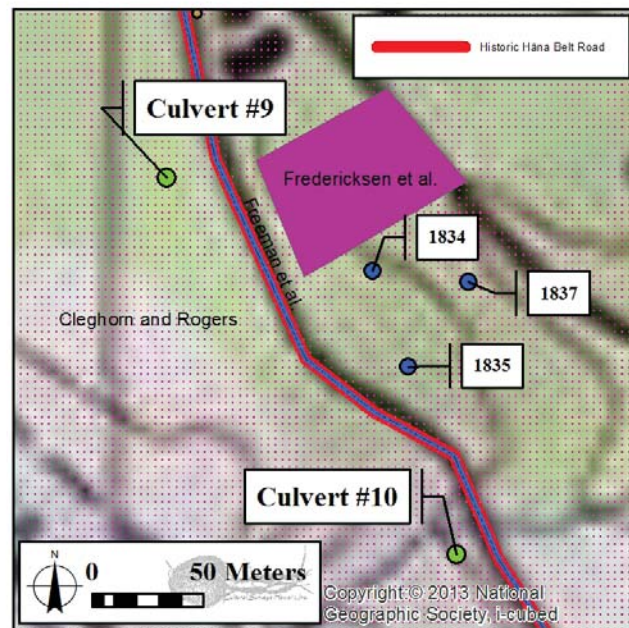
Kamakau describes the region of the Hana District in his book *Ruling Chiefs of Hawaii* as a place:

*....where taro, sweet potatoes, bananas, sugar cane and wild fruits grew in abundance, and there was always much food to be had. Kawaipapa was rich in fish from the ponds and from the sea.*<sup>5</sup>

No other specific cultural or archaeological background information could be located for this small section of land near Kawaipapa. However, refer to Section G, Appendix 1, Section 3.1.3.3 for the overall regional history of the Hana town vicinity; and to Section G, Appendix 1, Figure 17 for nearby archaeological study areas.<sup>6, 7, 8, 9</sup>

### *Adjacent Cultural Sites*

Three archaeological sites are located near historic Culvert #9 (refer to figure at right); SIHP -1834 (approximately 100 meters southeast), SIHP -1835 (approximately 140 meters southeast), and SIHP -1837 (approximately 144 meters southeast). These sites were recorded by Cleghorn and Rogers in their 1987 study of the Hana Ranch Lands, which consisted of compiling a list of known sites, analysis of aerial



3 F. S. Dodge, “Maui, Hawaiian Islands,” Library of Congress Geography and Map Division Washington, D.C. 20540-4650: Hawaiian Government Survey (Washington, D.C.: 1885).

4 Mary Kawena Pukui, Samuel H. Elbert, and Esther K. Mookini, *Place Names of Hawaii*, rev. and enl. ed. (Honolulu: University Press of Hawaii, 1974).

5 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).

6 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

7 Paul L. Cleghorn and Kathie Rogers, *Preliminary Historical and Archaeological Investigations of Hāna Ranch Lands, Maui Hawaiian Islands*, prepared for EDAW, Inc. (Honolulu: Department of Anthropology, Bernice Pauahi Bishop Museum, 1987).

8 David Perzinski and Michael F. Dega, “Archaeological Inventory Survey of a Hāna Highway Widening Area at Mile Marker 33.88, Culvert #9, Hāna, Kawaipapa Ahupua’a, Hāna District, Maui Island, Hawai’i [TMK: 1-4-006:999],” Scientific Consultant Services, Inc. (Honolulu: 2009).

9 Walter M. Fredericksen, Erik M. Fredericksen, and Demaris L. Fredericksen, “An Archaeological Inventory Survey on a Parcel of Land Located in the Ahupua’a of Kawaipapa and Niumalu, Hana District, Maui TMK: 1-4-06:2,” Xamanek Researches (Pukalani: 1993).

# CULVERT INFORMATION

photographs, and a brief field inspection.<sup>10</sup> SIHP -1834 was documented as a double-faced, core-filled stone wall that was disturbed due to road construction. SIHP -1835 consists of an overhang shelter with associated midden remains. SIHP -1837 appeared to be an historic stone retaining wall.<sup>11</sup> Refer to Section G, Appendix 1, Table 2: Previous archaeological studies conducted along Hana Highway, Route 360.

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<sup>10</sup> Paul L. Cleghorn and Kathie Rogers, Preliminary Historical and Archaeological Investigations of Hāna Ranch Lands, Maui Hawaiian Islands, prepared for EDAW, Inc. (Honolulu: Department of Anthropology, Bernice Pauahi Bishop Museum, 1987).

<sup>11</sup> Ibid.

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	Two Lanes
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	<ul style="list-style-type: none"><li>• Signs are in good condition</li><li>• Missing Object Marker Type 3 - Left (West Bound)</li><li>• Missing Object Marker Type 3 - Right (East Bound)</li></ul>
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	None
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

Culvert #9 is located at mile point 33.65 along Hana Highway, Route 360. Both ends of the culvert can be easily identified when traveling along the highway.

The roadway above the culvert is striped for two lanes, allowing vehicles to travel along the span of the culvert without yielding to oncoming traffic. Signage at the west culvert approach includes a “Left Object Marker” sign (OM3-L) located on the end of the left approach wall. Signage at the east culvert approach includes a “Right Object Marker” sign (OM3-R) located on the end of the right approach wall.

## Structural

Culvert #9 is a reinforced concrete slab culvert. At the time of the initial site visit on July 26, 2014, the culvert was still under construction. A site visit in early 2015 confirmed the completion of the construction work. The new curb-to-curb width of 26.3 feet allows for two-lane two-way traffic.

The upstream approach walls and parapet are original over the culvert. The downstream parapet and approach guardrails were demolished. The downstream Hana approach wall was constructed with a CRM facade and metal guardrails were placed at the downstream Kahului approach corner. The downstream parapet was replaced with a similarly designed concrete parapet.

At the time of the July 26, 2014 site visit, the upstream and downstream concrete parapets had a height of 27 inches and 30 inches, respectively.

Based on the record drawings:

- Downstream culvert parapet was designed “in accordance with AASHTO TL-2 design factors”,
- Design live load was AASHTO HL-93, and
- Seismic design based on “AASHTO Guide Specifications for LRFD Seismic Bridge Design (May 2007), as modified by the State of Hawaii Department of Transportation”.

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #9 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #9 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is not recommended since a detour through Hana Town can be utilized during repair and/or rehabilitation of this culvert.

Regarding the name and date of this culvert, discrepancies have been identified by comparing available modern and historic resources and in response to community comments during the preparation of this report. According to the HAER HI-75 report, Culvert #9 was constructed in 1915, identified by an inscription on the original downstream parapet (no longer extant).<sup>12</sup>

During the 2014 rehabilitation project, the downstream parapet was replaced with a new, solid concrete parapet without an inscription. However, a simple concrete name and date plaque was added to the exterior side of the upstream parapet during this project. The concrete plaque is inscribed "Holoina wa wae 1951" with diacritical marks; the date is incorrectly inscribed. Additionally, a 1934 parcel tax map indicates the feature crossed at this location is "Holoinawae Stream."<sup>13</sup>

It is recommended that the culvert name and feature crossed at this location be confirmed, and that the name and date plaque be changed to reflect the correct date of 1915 original construction. It is also recommended that the plaque be re-located at a more visible portion of Culvert #9 in approach walls (refer to "CRM Approach Walls" section). The name of this culvert shall be verified through a process to be determined during future development of

<sup>12</sup> "Hana Belt Road," Historic American Engineering Record, HAER HI-75 (2005), 86.

<sup>13</sup> Tax Maps Bureau & Survey Department, "Hana, Maui," file number: M14003, dwg no: 2088, Second Division, Zone 1, Section 4, Plat 03, County of Maui, State of Hawaii (1934).



# RECOMMENDATIONS

a PA between the ACHP, SHPD, FHWA, and HDOT, including other concurring parties. Refer to Section G, Appendix 10. *Hawaiian Place Names Research* for further research and discussion.

*Recommendations have been identified per culvert component, as follows:*

## **Deck**

There are no record drawings for the original portion (upstream end) of this culvert. It is recommended to have the original deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the original deck is capable of supporting the new railing and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

The widened portion of the culvert is not to be affected.

AC overlay thickness shall not obstruct the base or lower the height of the existing railings. If excessive AC overlay is present at the time of the future design team's site survey, then it is recommended to remove the excess AC overlay and reapply. As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

## **CRM Approach Walls**

The existing upstream CRM walls at the approaches to the culvert do not meet the TL-2 crash requirements and cannot act as the culvert's traffic features. The existing CRM approach walls are recommended to be replaced with a reinforced concrete wall with a new natural rock façade. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). To eliminate the potential of a blunt end collision occurring, it is recommended to install guardrails and an end treatment at the upstream approach corners to the culvert after the stone masonry guardwall.



*Culvert #9 upstream elevation with incorrect date inscription  
Courtesy of FAI*



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

# RECOMMENDATIONS

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*). The approach walls shall also contain a concrete culvert name panel, pending confirmation of the Hawaiian place name by community and scholarly experts. Refer to Section A, Chapter 5. iii. a. *Approach Walls & Safety Features at the Approaches* for an example of the stone masonry guardwall with bridge name detail.

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## ***Railings / Parapets***

The upstream concrete culvert parapet does not meet TL-2 crash requirements. It is recommended to construct a crash-tested railing in front of the existing upstream parapet. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). Since record drawings are not available for the original portion of the culvert, additional investigation of the deck is recommended (refer to “Deck” section). Also, drainage should be provided through the base of each parapet.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

The CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current material composition of the original concrete abutments, upstream CRM wingwalls, and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The original portion of the culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert’s lifespan. If it is determined necessary to rehabilitate the concrete foundations, it is recommended to be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

# RECOMMENDATIONS

## ***Load Rating***

Load rating for the original portion of the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3). The widen portion of the culvert is able to support the 40-ton load criteria.

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

- Add Object Markers to approach walls

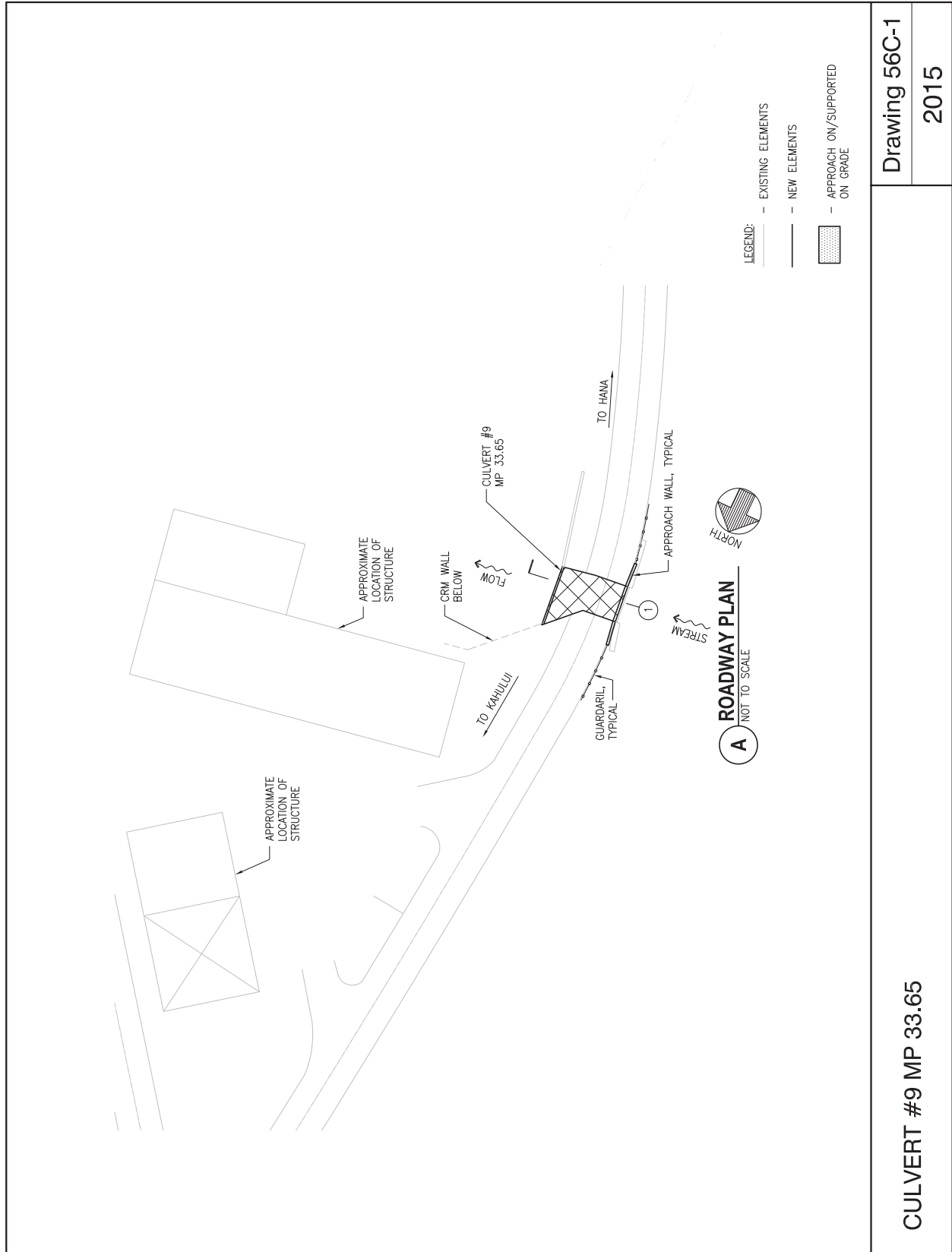
Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

## ***Electrical***

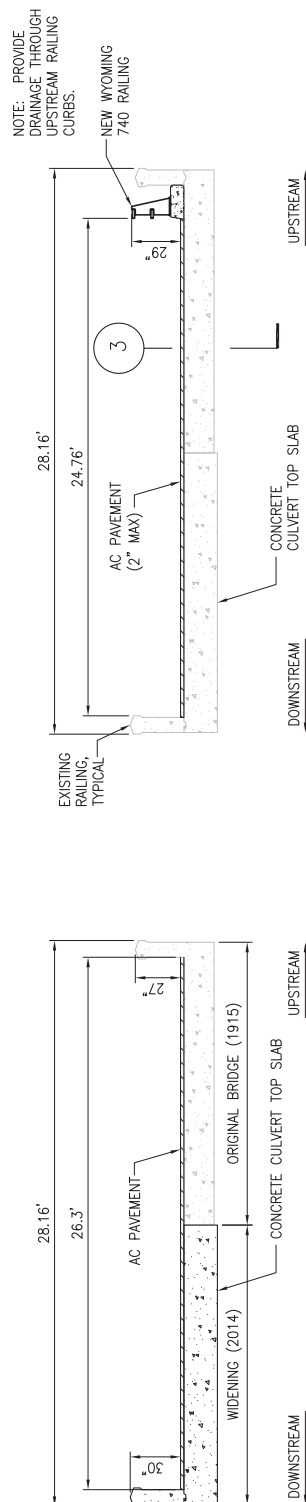
Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #9 at this time.



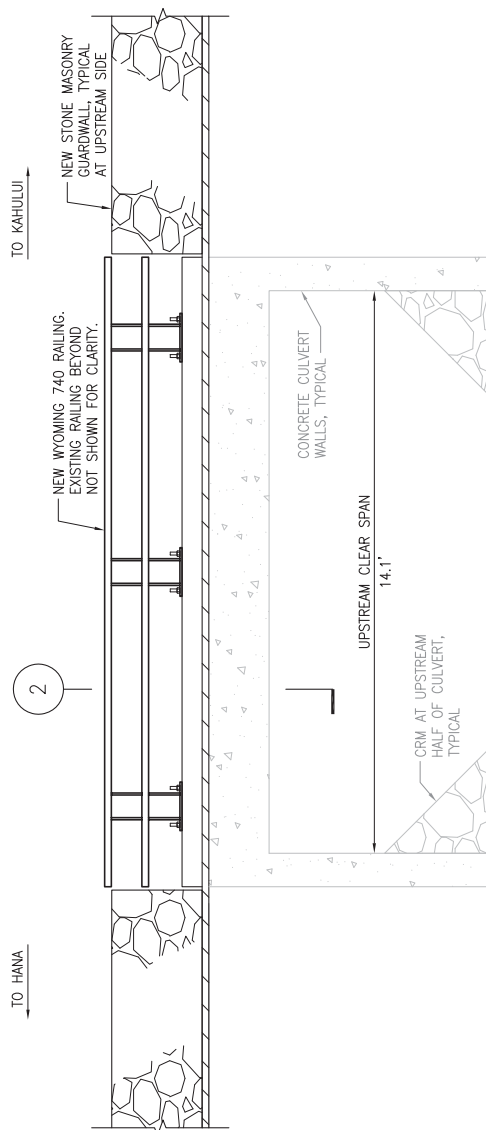
# CURRENT DRAWINGS



CULVERT #9 MP 33.65		Drawing 56C-1
		2015



**2** SECTION TYPICAL (NEW)  
NOT TO SCALE



**3** **LONGITUDINAL SECTION (NEW)**  
NOT TO SCALE

\*ALL DIMENSIONS ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.

Drawing 56C-2

2015

Culvert #10

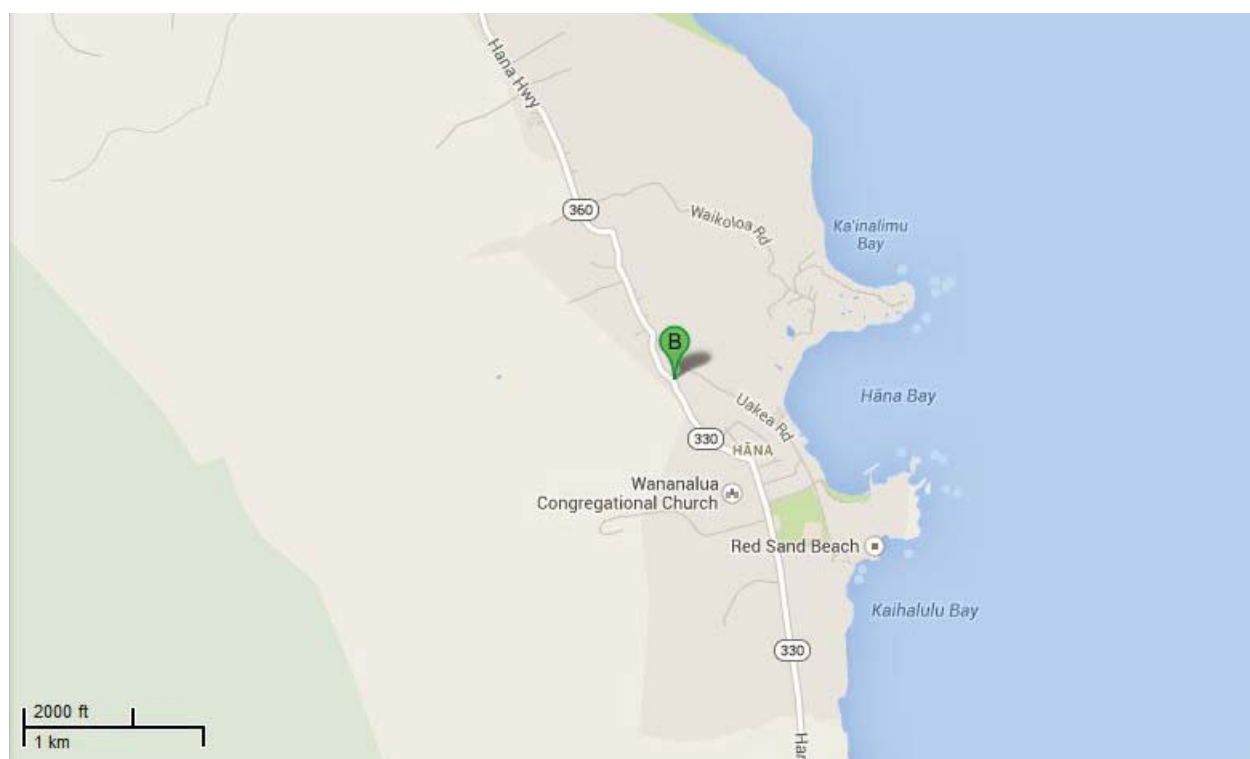
57C



57C

## CULVERT #10

Culvert Number					Island	Maui
Date of Construction	Unknown				Route	Hana Highway
Treatment Recommendation	X	Preservation	X	Rehabilitation	Restoration	Replacement



Courtesy of Google Maps

# CULVERT INFORMATION

## Location

<b>Latitude</b>	20d 45m 38s
<b>Longitude</b>	155d 59m 33s
<b>Mile Point</b>	34.00

## Culvert Features

<b>Culvert Type</b>	Concrete Slab Culvert
<b>Total Length</b>	Culvert Length = 14.10 feet
<b>Number of Spans</b>	1
<b>Clear Span</b>	14.08 feet
<b>Clear Height</b>	8 feet (approx)
<b>Deck Width</b>	Curb-to-Curb = 12.5 feet
<b>Abutment Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Walls</li></ul>
<b>Wingwall Material</b>	<ul style="list-style-type: none"><li>• CRM Wingwalls</li></ul>
<b>Floor / Decking Material</b>	<ul style="list-style-type: none"><li>• Reinforced Concrete Top Slab</li><li>• Unlined Bottom</li></ul>
<b>Parapet / Railing Type</b>	Solid Concrete Parapets
<b>Parapet / Railing Segments</b>	1
<b>Parapet / Railing Height</b>	<ul style="list-style-type: none"><li>• Upstream Railing Height = 27 inches</li><li>• Downstream Railing Height = 27 inches</li></ul>
<b>Parapet Profile</b>	<ul style="list-style-type: none"><li>• Rectangular Cap</li><li>• Flat Parapet with Board-Formed Concrete Texture</li><li>• No Panel</li></ul>
<b>Parapet Inscription</b>	"1915" on downstream face

# CULVERT INFORMATION

## Culvert Features

Culvert #10 is located at mile point 34.00. The culvert measures 14.1 feet in length and has a clear opening of approximately 14.1 feet wide by 8 feet high. The top slab and walls are concrete and the bottom is an unlined channel.



*Kahului approach to Culvert #10 toward Hana  
Courtesy of NOEI*



*Hana approach to Culvert #10 toward Kahului  
Courtesy of NOEI*



*Concrete abutments  
Courtesy of NOEI*



*Solid parapet  
Courtesy of NOEI*



# CULVERT INFORMATION

## Significance & Context

<b>Ahupuaa</b>	Kawela
<b>Designer / Builder</b>	Unknown
<b>Historic Drawings</b>	None
<b>Alterations</b>	None
<b>Replacement</b>	None
<b>Preservation Priority</b>	Contributing Culvert
<b>State / National Register</b>	Yes
<b>Areas of Significance</b>	Engineering, Social History, Transportation, Commerce
<b>Significance Statement</b>	<ul style="list-style-type: none"> <li>• Contributes to the Hana Highway Historic Bridge District</li> <li>• Part of best remaining intact example of a belt road system in the state</li> <li>• 20th century example of culvert engineering and construction</li> <li>• See National Register of Places Nomination Form in appendices</li> <li>• HAER Recordation: HI-75 (2005)</li> </ul>
<b>Archaeological / Cultural Significance</b>	<ul style="list-style-type: none"> <li>• Greater than 50 years in age</li> <li>• Part of the Hana Belt Road, which retains a high level of historic integrity and character, and which includes the highest concentration of stylistically consistent historic bridges and culverts in the State of Hawaii</li> <li>• Relatively unaltered in terms of historic setting and character, including location, width, alignment, scenery, and vistas</li> </ul>
<b>Adjacent Cultural Sites</b>	None Documented
<b>Geographical Features / Setting</b>	<ul style="list-style-type: none"> <li>• Heavy vegetation</li> </ul>
<b>Character Defining Features</b>	<ul style="list-style-type: none"> <li>• Box Culvert</li> <li>• Concrete Abutment Walls</li> <li>• CRM Wingwalls</li> <li>• Concrete Solid Parapet with Board-Formed Texture</li> <li>• Inset inscription "1915" on outside face of downstream parapet</li> </ul>
<b>Detracting Features</b>	<ul style="list-style-type: none"> <li>• Excessive asphalt</li> </ul>



# CULVERT INFORMATION

## Significance & Context

### *Archaeological / Cultural Significance*

Culvert #10 is located along Hana Highway, Route 330, just south of the junctions with Hana Highway, Route 360. The culvert lies in Niumalu Ahupuaa.<sup>1</sup> The place name *Niumalu* is defined as, “Land sections, Kau-po and Hana qds... *Lit.*, shade [of] coconut trees.”<sup>2</sup>

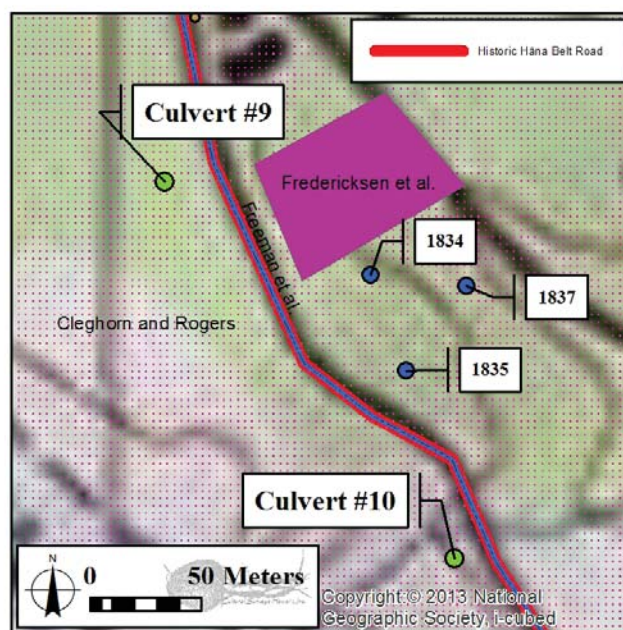
Kamakau describes the region of the Hana District in his book *Ruling Chiefs of Hawaii* as a place:

*...where taro, sweet potatoes, bananas, sugar cane and wild fruits grew in abundance, and there was always much food to be had. Kawaipapa was rich in fish from the ponds and from the sea.*<sup>3</sup>

No other specific cultural or archaeological background information could be located for this small section of land near Kawaipapa. However, refer to Section G, Appendix 1, Section 3.1.3.3 for the overall regional history of the Hana town vicinity; and to Section G, Appendix 1, Figure 17 for nearby archaeological study areas.<sup>4,5</sup>

### *Adjacent Cultural Sites*

Three archaeological sites are located near historic Culvert #10 (refer to figure at right); SIHP -1834 (approximately 135 meters north-northwest), SIHP -1835 (approximately 85 meters north-northwest), and SIHP -1837 (approximately 125 meters north). These sites were recorded by Cleghorn and Rogers in their 1987 study of the Hana Ranch Lands, which consisted of compiling a list of known sites, analysis of aerial photographs, and a brief field inspection.<sup>6</sup> SIHP -1834 was documented as a double-faced, core-filled stone wall that was disturbed due to road construction. SIHP -1835 consists of an overhang shelter with associated midden remains. SIHP -1837 appeared to be an historic stone retaining wall.<sup>7</sup> Refer to Section G, Appendix 1, Table 2: Previous archaeological studies conducted along Hana Highway, Route 360.



1 F. S. Dodge, “Maui, Hawaiian Islands,” Library of Congress Geography and Map Division Washington, D.C. 20540-4650: Hawaiian Government Survey (Washington, D.C.: 1885).

2 Mary Kawena Pukui, Samuel H. Elbert, and Esther K. Mookini, *Place Names of Hawaii*, rev. and enl. ed. (Honolulu: University Press of Hawaii, 1974).

3 S. M. Kamakau, *Ruling Chiefs of Hawaii*, rev. ed. (Honolulu: The Kamehameha Schools Press, 1992).

4 Sallie D. M. Freeman, Holly J. Formolo, and Hallett H. Hammatt, “An Archaeological Monitoring Report for Hāna Highway Improvements Huelo to Hāna, M.P. 4.20 to 23.70 Districts of Makawao (Hāmākualoa and Ko’olau) and Hana, Island of Maui (TMK: 2-1-1; 2-1-2; 2-1-3; 2-1-4; 01-05; and 2-2-9:05, 06, 09, 10, 12, 13),” Cultural Surveys Hawai’i, Inc. (Wailuku: 2004).

5 Paul L. Cleghorn and Kathie Rogers, *Preliminary Historical and Archaeological Investigations of Hāna Ranch Lands, Maui Hawaiian Islands*, prepared for EDAW, Inc. (Honolulu: Department of Anthropology, Bernice Pauahi Bishop Museum, 1987).

6 Ibid.

7 Ibid.

# CULVERT INFORMATION

## Civil & Traffic

<b>Number of Lanes</b>	One Lane
<b>Bicycle / Pedestrian Access</b>	N/A
<b>Visibility / Approach</b>	N/A
<b>Signage</b> (as of September 2014)	<ul style="list-style-type: none"><li>• Signs are in good condition</li><li>• Missing Object Marker Type 3 - Left &amp; Right (West Bound)</li></ul>
<b>Apron</b>	None
<b>Civil Utilities</b>	None
<b>Easements</b>	None
<b>Public Right-of-Way</b>	Per HDOT, there are no Right-of-Way maps in this area

## Structural

<b>Construction Access / Bypass Bridge</b>	Temporary bypass downstream side
<b>Electrical Utilities</b>	None
<b>Load Rating</b>	Unknown
<b>Condition</b>	Unknown

# CULVERT INFORMATION

## Civil & Traffic

Culvert #10 is located at mile point 34.00 along Hana Highway, Route 360. Both ends of the culvert can be easily identified when traveling along the highway.

The travel way above the culvert is striped for one-way travel, forcing vehicles to yield to oncoming traffic. Signage and striping at the east and west culvert approach include a “Yield” sign (R1-1), a “To Oncoming Traffic” sign (R1-2a), and a yield line. The east culvert approach also includes a “Left Object Marker” sign (OM3-L) on the end of the left side approach wall and a “Right Object Marker” sign (OM3-R) on the end of right side approach wall.

## Structural

Culvert #10 is a one-lane reinforced concrete slab culvert. There are no approach walls or guardrails at this culvert. The upstream and downstream concrete parapets have a height of 27 inches. Neither parapet has been crash-tested for a TL-2.

The current curb-to-curb dimension is approximately 12.50 feet. This curb-to-curb dimension does not meet this project’s design criteria of 16 feet.

Load rating for this culvert unknown and therefore, it is assumed that the minimum load is 10 tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

# RECOMMENDATIONS

## Recommendation

It is recommended that the existing culvert structure of Culvert #10 be rehabilitated. Any rehabilitation work to this culvert will need to consider the historical and cultural areas in its surroundings during design and construction. Recommendations are based on site visits conducted during the months of May, June, and July of 2014. Refer to Section A, Chapter 5. *Application of Design Standards & Guidelines* for more information.

Preservation and maintenance of the existing structure should be continued until structural deficiencies and/or upgrades to address current safety standards are determined necessary. A list of maintenance activities specific to Hana Highway, Route 360 historic culverts is included in Section A, Chapter 4. iv. *Preservation Solutions Following Secretary of the Interior's Standards*, and Chapter 5. iii. f. *Activities to Prolong the Life of the Bridge*, for reference. Damaged character-defining features should be stabilized and repaired to prevent future deterioration. If Culvert #10 is to be rehabilitated, any rehabilitation work to this culvert will need to comply with the SOI Standards. All strengthening or rehabilitation construction activities are subject to NHPA Section 106 and HRS Chapter 6E consultation with SHPD and Maui CRC.

An archaeological inventory survey is recommended prior to any construction in the APE for culvert rehabilitation, as this culvert contributes to the Hana Highway Historic Bridge District (refer to Section G, Appendix 4 for Hana Belt Road National Register Nomination Form).

A localized topographic study is recommended in order to give further analysis of the drainage patterns and runoff capacity of the culvert in question.

A temporary bypass bridge is recommended during repair and/or rehabilitation for all culverts in this report. The future contractor shall be responsible for providing and maintaining the temporary bridge during the course of the culvert rehabilitation.

*Recommendations have been identified per culvert component, as follows:*

### **Deck**

Culvert #10 currently does not meet the minimum curb-to-curb width of 16 feet for a one-lane culvert; therefore, it is recommended to widen the upstream side of the culvert. Special attention should be paid to removing excess asphalt overlay on the deck because it obscures the base of the existing parapets and lowers the height below code minimum.

There are no record drawings for this culvert. It is recommended to have the deck scanned for reinforcing and have core samples extracted. The results will assist in determining whether the deck is capable of supporting the new railings and a 40-ton load carrying capacity. A chloride concentration analysis is recommended to be conducted on the concrete core samples.

As a design consideration, suggested by the communities adjacent to Hana Highway, the future design team shall consult with FHWA, HDOT, and SHPD whether to provide a concrete topping versus AC on the culverts.

# RECOMMENDATIONS

## **CRM Approach Walls**

Currently, there are no approach walls at this culvert; therefore, it is recommended to install approach walls at all approach corners. The approach wall will consist of a reinforced concrete wall with a natural rock façade to match the appearance of other culverts along Hana Highway. For this purpose, a stone masonry guardwall is recommended to be used (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing Options*). To eliminate the potential of a blunt end collision occurring, it is recommended to install guardrails and an end treatment at the approach corners to the culvert after the stone masonry guardwall.



*Exemplary CRM approach wall, Bridge #19 Kopiliula Stream Bridge  
Courtesy of NOEI*

New approach walls shall be designed to be independent of the culvert parapets; a space is recommended between parapets and approach walls. A maximum space of 0.5 inches shall be maintained between culvert parapets and adjacent approach walls using joint filler (refer to Section A, Chapter 5. iii. a. *Approach Walls and Safety Features at the Approaches*).



*Exemplary CRM approach wall, Bridge #38 Heleleikeoha Stream Bridge  
Courtesy of NOEI*

The appearance of the reconstructed CRM façades shall closely match that of the original historic craftsmanship along Hana Highway. The surface of the rock façade shall not exceed 0.5 inches in variation. Examples of exemplary historic craftsmanship, with tight joints, minimal exposed mortar, and varied rock sizes for a natural, rustic appearance, may be seen at the approach walls to the following bridges: #19 Kopiliula Stream Bridge, #38 Heleleikeoha Stream Bridge, #39 Ulaino Stream Bridge, and #40 Mokulehua Stream Bridge for reference. The rock wall portions of the EMI system at #06 Kaaiea Stream Bridge and #19 Kopiliula Stream Bridge are also excellent examples of historic rock walls showing original craftsmanship.

## **Railings / Parapets**

The concrete culvert parapets do not meet TL-2 crash requirements. It is recommended to preserve, relocate, and connect the existing upstream parapet to the new widened portion of the deck. A crash-tested railing will be constructed in front of the existing parapets. For this purpose, it is recommended to use a Wyoming 740 railing which will be attached to the deck of the culvert (refer to Section G, Appendix 5. *Proposed Crash-Tested Railing*



*Culvert #10 downstream elevation with inscription  
Courtesy of NOEI*



# RECOMMENDATIONS

*Options*). Since record drawings are not available, additional investigation of the deck is recommended (refer to “Deck” section). Also, drainage should be provided through the base of each parapet.

At the time of design, the recommended railings shall be verified whether they meet current crash-test standards. Substitution of the recommended railing may be necessary if they are no longer acceptable.

## ***Foundations, Wingwalls, & Abutments***

The CRM wingwalls are recommended to be replaced with a reinforced concrete structure with new natural rock façades. The appearance of the reconstructed façades shall closely match that of the original historic craftsmanship along Hana Highway.

It is recommended to investigate the current material composition of the concrete abutments and foundations to determine whether they need to be rehabilitated to be compliant with current seismic codes and the increase to a 40-ton load carrying capacity. The culvert should be scanned for reinforcing and have concrete core samples extracted. A condition survey is recommended to determine corrosion potential to base the selection of repair and protection strategy to prolong the culvert’s lifespan. . If it is determined necessary to rehabilitate the concrete abutments and foundations, they are recommended to be replaced in-kind with a reinforced concrete structure.

Until future rehabilitation work is determined, retention of the existing appearance of CRM wingwalls, which show evidence of historic craftsmanship is recommended through preservation and routine maintenance.

## ***Load Rating***

Load rating for the culvert has not been completed due to lack of information (refer to “Deck” section). It is assumed that the culvert can support at a minimum the posted 10-tons per the general posted load sign at the beginning of Hana Highway (between mile markers 2 and 3).

After rehabilitation at the culvert is complete, a load rating calculation shall be performed per current load rating standards. Per the request of the communities adjacent to the Hana Highway, the culvert shall not be posted with a 40-ton sign after rehabilitation is completed.

## ***Civil, Traffic, & Signage***

In regard to visibility on each approach, any obstructions blocking the driver’s visibility should be trimmed or removed per an approved landscape plan. Signage and striping shall be compliant with current standards by referring to the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*, 2009 edition by the FHWA or the most current edition/revision of this book. Signage, visibility, and traffic recommendations include the following:

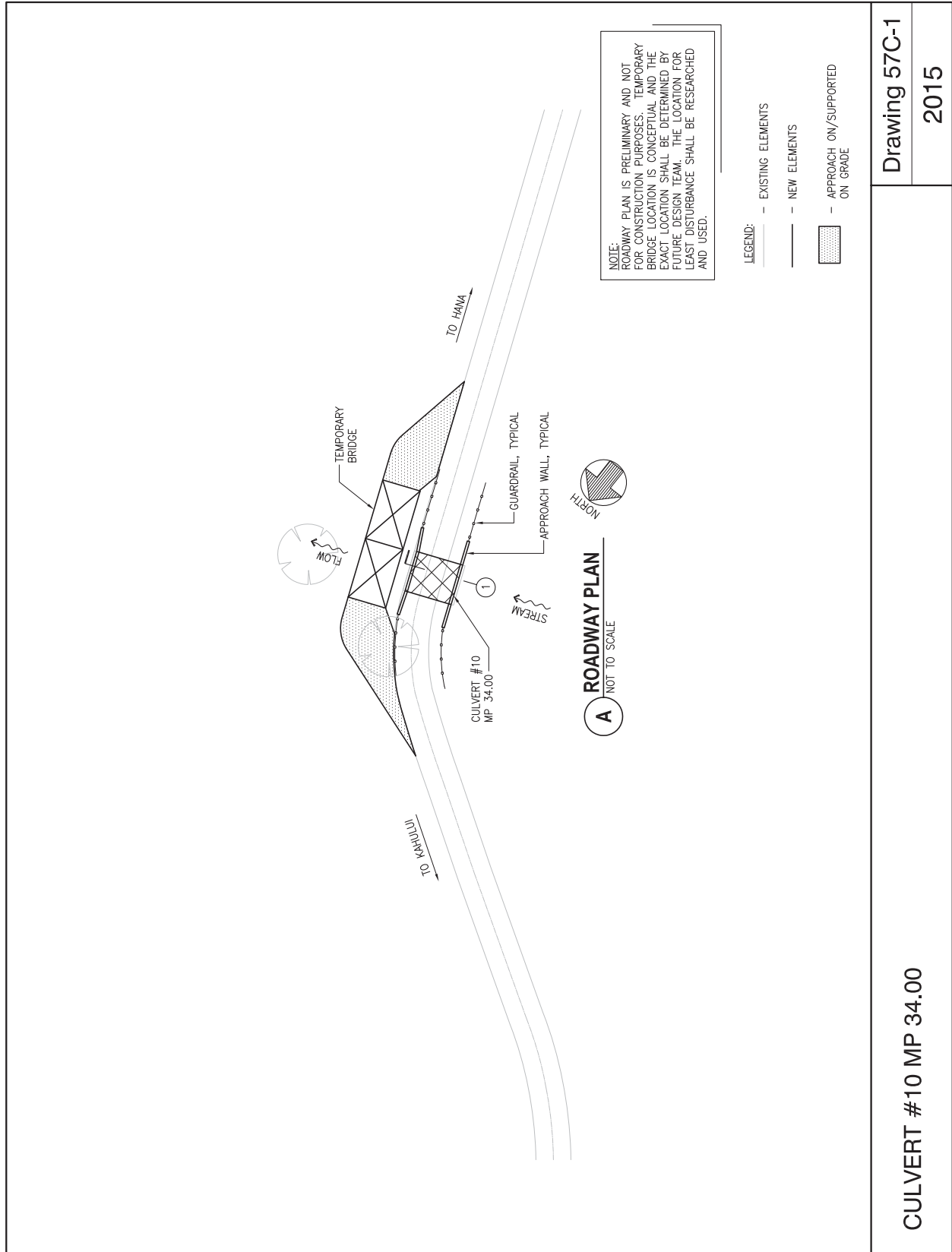
- Add Object Markers to approach walls

Existing field conditions should be field verified before applying any recommendations as maintenance work could have been conducted and corrected the deficiencies noted in this report. Refer to Section G, Appendix 2. *Transportation Management Plan - Hana Highway Bridge Preservation Plan* for more information.

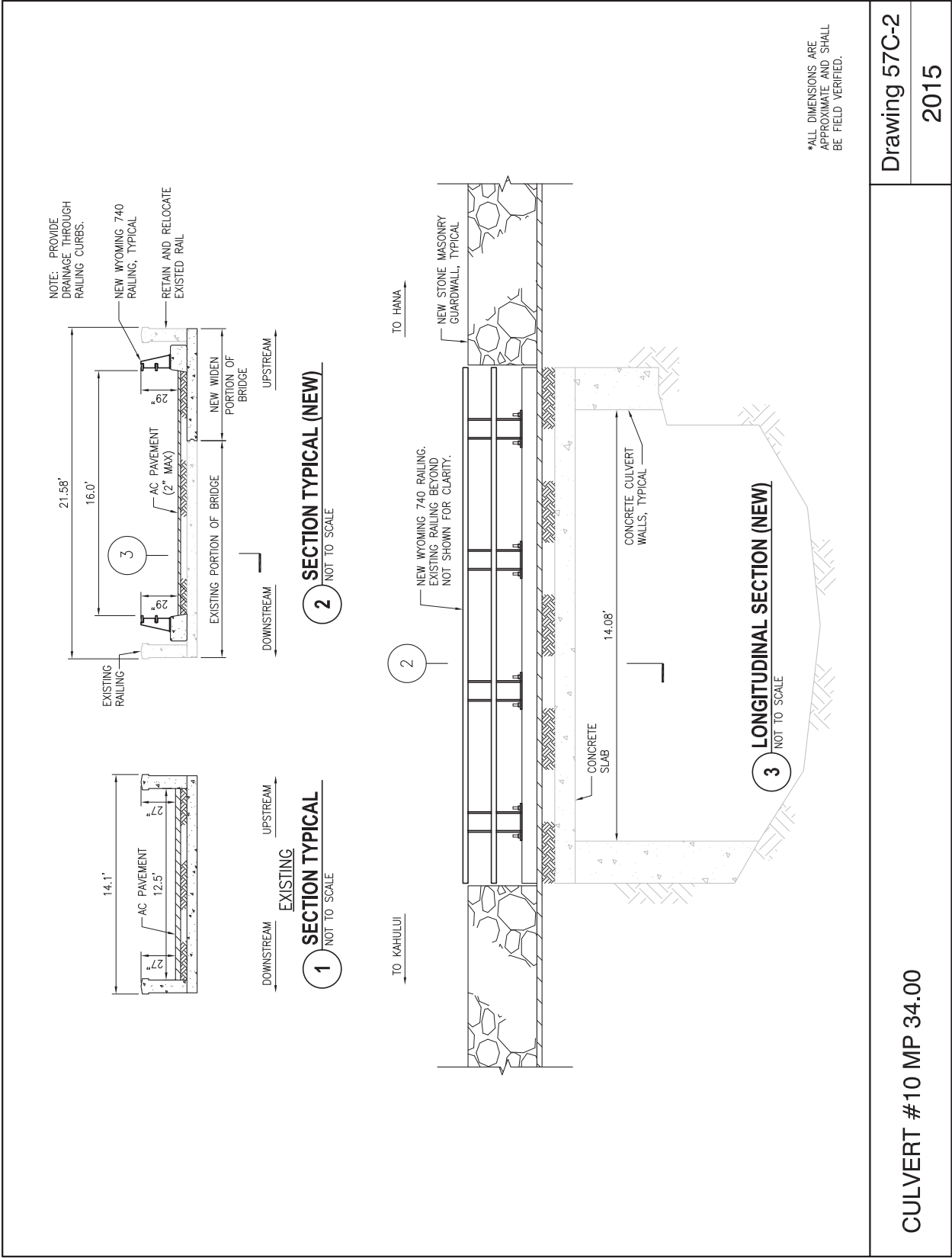
# RECOMMENDATIONS

## ***Electrical***

Based on site visit observations and current conditions at the time this report was prepared, there are no electrical recommendations for Culvert #10 at this time.







Drawing 57C-2  
2015

CULVERT #10 MP 34.00

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# **SECTION D**

## **FOUND CULVERTS**



## FOUND CULVERTS OVERVIEW

In addition to the 43 bridges and 12 HAER culverts, there are numerous smaller culverts along Hana Highway's Historic Belt Road. Most of these culverts are documented on past HDOT paving plans; however, their locations were not confirmed and they are not inspected on a regular basis due to their sizes and intended purpose. The majority of these culverts are small box or pipe culverts that travel under the highway and appear to be utilized as a means of drainage from upstream properties.

The HDOT requested that the additional culverts and their locations be confirmed through a visual drive of Hana Highway, Route 360 with guidance from past paving project plans. Some of the culverts could not be located; therefore, culverts that were confirmed during the course of this project were referred to as "found" culverts. A total of 45 found culverts with visible headwalls above or next to the AC roadway were discovered. The found culverts can be categorized by the following structure types and materials:

- Reinforced concrete pipes (RCP): 19 total found,
- Reinforced concrete and rock box culverts: 20 total found,
- Corrugated metal pipes (CMP): Five total found, and
- Unknown: One total found.

The unknown culvert was found at mile point 14.91 with a CRM headwall, but the upstream inlet did not have any openings (refer to *Figure D – 1*, below).



*Figure D – 1: Backside view of upstream headwall at mile point 14.91  
Courtesy of NOEI*

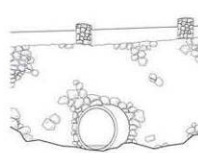
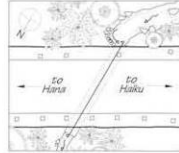
Record drawings do not exist for these found culverts and it is unknown as to when they were constructed. The HAER report mentions and describes culvert types found along the Hana Highway, Route 360 (refer to *Figure D – 2*). The load carrying capacities of these culverts are unknown since as-built drawings are not available for these structures, nor have condition evaluations for them been performed. At the time of the survey, the found culverts were found to be in good condition. It is recommended that the found culverts be investigated to determine their load carrying capacity and code compliance.

# CULVERT TYPOLOGIES OF THE HANA BELT ROAD

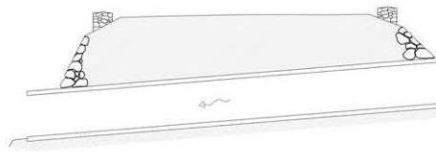
A culvert is a structure that allows water to be carried transversely beneath a roadway. Hundreds of culverts were required to provide drainage along the Hana Belt Road, and over the years, various types of structures were utilized. During the initial construction of the road, corrugated iron-pipe culverts and flat slab culverts were installed. Pipe culverts were built beneath the roadway and sloped at a two to three percent grade to direct the water runoff. Flat slab culverts were bridges with spans less than 20' in length. Just like other bridges on the road, the culverts were built with flat-slabs for the road deck with concrete or rubble masonry abutments and wingwalls. In more recent decades, concrete pipe culverts have been used. Drop culverts are a variation of the pipe culvert, with the defining characteristic being a vertically aligned catch basin that directs water into the pipe. The catch basin is typically built of dry-stacked or mortared lava rock. Pipe and drop culverts are practical where the road has little or no shoulder for an intake basin.

## PIPE CULVERT

(MILE 8.9)

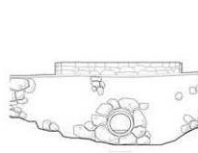
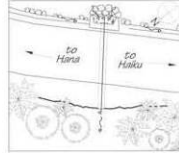


3'-6" [1.07m]

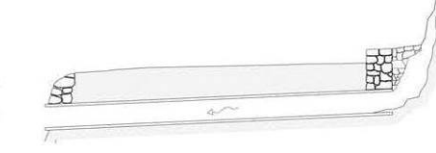


## DROP CULVERT

(MILE 17.6)

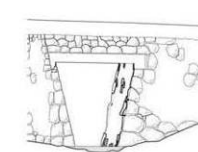
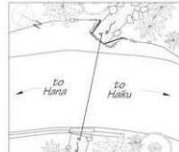


2'-0" [0.61m]

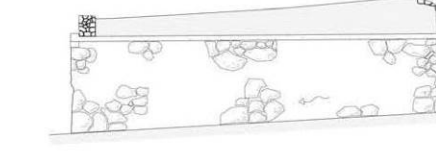


## CRM CULVERT

(MILE 3.7)

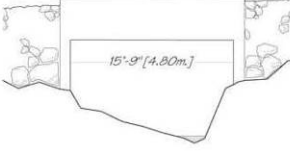
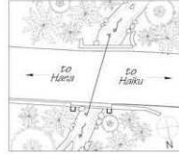


7'-6 13/16" [2.31m]

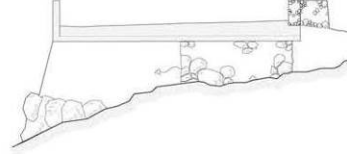


## SLAB CULVERT

(MILE 17.5)

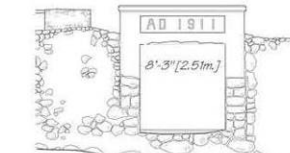
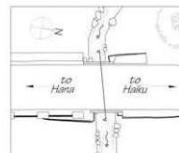


15'-9" [4.80m]

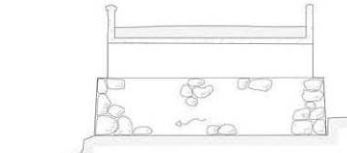


## BOX CULVERT

(MO'OMONUI CULVERT)



8'-3" [2.51m]



Plan  
SCALE: 1/16" = 1'-0"  
0 10 20 40 FEET

Makai Elevation  
SCALE: 1/4" = 1'-0" 0 5 10 FEET

Section  
SCALE: 1/4" = 1'-0" 0 5 10 FEET

DELINEATED BY: DANIEL SCHAELE, 2005

HANA HIGHWAY  
RECORDING PROJECT  
NATIONAL PARK SERVICE  
UNITED STATES DEPARTMENT OF THE INTERIOR

HANA VICINITY

HANA BELT ROAD (HANA HIGHWAY)  
BETWEEN HAKU AND KIPAHULU (STATE HIGHWAY 360/COUNTY HIGHWAY 31)  
MAUI

HAWAII

SHEET  
8 OF 13

HISTORIC AMERICAN  
ENGINEERING RECORD  
HI-75

DATE: 1/2005  
DRAWN: [illegible]

Figure D – 2: Culvert typologies of the Hana Belt Road  
Courtesy of HAER HI-75

It is recommended that culverts with CRM approach walls have the existing approach walls replaced with a crash-tested reinforced concrete wall with a natural rock façade to match the appearance of the existing CRM wall. For this purpose, a stone masonry guardwall is recommended. It is also recommended to install guardrails and an end treatment at the corners after the stone masonry guardwall, to eliminate the possibility of a blunt end collision.

# Found Culvert Matrix

## Hana Highway, Route 360

Mile Point (MP)	Culvert Type	Drawing No. for		"A" Length of wall**	"B" Ht of wall (or metal guardrail) above roadway***		"C" Interior width or Diameter	"D" Interior Height
		Plan	Section		Upstream	Downstream		
1C	Pipe	1C-1	C-2	-	2'-0"	N/A	2'-0"	-
3C	Pipe	3C-1 & 4C-1	C-2	5'-0" (upstream)	0'-3"	2'-0"	2'-0"	-
4C	Rectangular	3C-1 & 4C-1	C-2	62'-0" (upstream) & 43'-6" (downstream)	1'-6"	1'-6"	5'-0"	10'-0"
5C	Rectangular	5C-1	C-2	37'-0" (upstream)	2'-0"	N/A	8'-0"	8'-0"
6C	Rectangular	6C-1	C-2	28'-0" (upstream) & 25'-0" (downstream)	2'-6"	2'-2"	3'-0"	3'-0"
7C	Pipe	7C-1	C-2	30'-0" (upstream)	1'-9"	N/A	2'-0"	-
8C	Rectangular	8C-1	C-2	24'-0" (upstream)	2'-0"	N/A	2'-0"	1'-0"
9C	Pipe	9C-1	C-2		N/A	2'-0"	2'-0"	-
10C	Rectangular	10C-1	C-2	16'-0" (upstream) & 27'-7" (downstream)	2'-0"	2'-0"	4'-0"	8'-0"
11C	Unknown*	11C-1	C-2	15'-0" (upstream) & 15'-0" (downstream)	2'-0"	1'-8"	-	-
12C	Pipe	12C-1	C-2	22'-6" (upstream)	2'-0"	N/A	2'-0"	-
13C	Rectangular	13C-1	C-2	44'-8" (upstream) & 1'-9" (downstream)	2'-0"	1'-9"	12'-0"	5'-0"
14C	Pipe	14C-1 & 15C-1	C-2	10'-0" (upstream)	1'-0"	2'-6"	2'-0"	-
15C	Pipe	14C-1 & 15C-1	C-2	6'-0" (upstream)	1'-6"	N/A	2'-0"	-
16C	Pipe	16C-1	16C-2	32'-6" (downstream)	N/A	2'-3"	3'-6" (3 pipes) & 2'-0" (1 pipe)	-
17C	Pipe	17C-1	17C-2	14'-0" (downstream)	2'-6"	N/A	2'-0" (1 pipe) & 3'-0" (1 pipe)	-
18C	Pipe	18C-1	C-2	-	N/A	N/A	Unknown	-
22C	Rectangular	22C-1 & 23C-1	C-2	-	2'-7"	1'-4"	11'-9"	5'-4" (upstream) & 9'-2" (downstream)
23C	Pipe	22C-1 & 23C-1	C-2	-	1'-0"	N/A	2'-0"	-
24C	Pipe	24C-1	C-2	-	1'-7"	2'-4"	2'-0"	-
26C	Pipe	26C-1	C-2	-	2'-0"	2'-6"	2'-6"	-
27C	Pipe	27C-1	C-2	-	1'-6"	2'-6"	3'-0"	-
28C	Pipe	28C-1	C-2	-	1'-9"	2'-0"	4'-0"	-
29C	Rectangular	29C-1	C-2	22'-0" (upstream) & 28'-6" (downstream)	1'-1"	2'-1"	6'-0"	8'-0"
30C	Rectangular	30C-1	C-2	39'-0" (upstream) & 38'-2" (downstream)	2'-3"	1'-3"	9'-0"	8'-0"
31C	Pipe	31C-1	31C-2	-	2'-2"	2'-4"	2'-0"	-
32C	Pipe	32C-1	32C-2	-	0'-6"	2'-4"	2'-0" (2 pipes)	-





# Found Culvert Matrix

## Hana Highway, Route 360

	Mile Point (MP)	Culvert Type	Drawing No. for		"A" Length of wall**	"B" Ht of wall (or metal guardrail) above roadway***		"C" Interior width or Diameter	"D" Interior Height
			Plan	Section		Upstream	Downstream		
33C	22.10	Rectangular	33C-1	C-2	-	2'-4"	2'-0"	4'-0"	4'-0"
34C	22.52	Rectangular	34C-1 & 35C-1	C-2	-	2'-2"	2'-4"	4'-0"	4'-0"
35C	22.54	Pipe	34C-1 & 35C-1	C-2	-	2'-1" (parapet) & 2'-4" (metal guardrail)	2'-2" (parapet) & 2'-3" (metal guardrail)	1'-6"	-
36C	22.79	Rectangular	36C-1	C-2	-	2'-4"	2'-4"	8'-0"	3'-0"
37C	22.90	Pipe	37C-1	C-2	-	2'-4"	2'-1"	2'-0"	-
38C	23.04	Pipe	38C-1	C-2	-	2'-0"	2'-0"	4'-0"	-
39C	23.21	Rectangular	39C-1 & 40C-1	C-2	-	2'-0"	2'-0"	4'-0"	6'-0"
40C	23.26	Pipe	39C-1 & 40C-1	C-2	-	0'-10"	2'-5"	3'-0"	-
41C	23.70	Pipe	41C-1	C-2	-	1'-7"	2'-3"	4'-0"	-
43C	24.38	Pipe	43C-1	C-2	-	N/A	0'-11"	2'-0"	-
44C	24.71	Rectangular	44C-1	C-2	-	N/A	1'-6"	2'-0"	2'-0"
45C	24.90	Rectangular	45C-1	C-2	-	N/A	1'-2"	3'-0"	3'-0"
46C	26.13	Rectangular	46C-1	C-2	-	2'-0"	2'-5"	4'-0"	4'-0"
47C	26.33	Rectangular	47C-1	C-2	-	N/A	2'-0"	2'-0"	1'-0"
48C	27.26	Pipe and Rectangular	48C-1 & 49C-1	48C-2	-	1'-8"	0'-10"	3'-0" diameter (upstream) & 8'-0" width (downstream)	5'-0"
49C	27.41	Pipe	48C-1 & 49C-1	C-2	-	N/A	0'-9"	2'-0"	-
50C	27.60	Rectangular	50C-1 & 51C-1	C-2	-	N/A	2'-3"	2'-6"	2'-6"
51C	27.70	Rectangular	50C-1 & 51C-1	C-2	-	N/A	1'-6"	2'-6"	1'-0"

\*Culvert MP 14.91 - culvert was not found, and may be buried under debris. Refer to Section D, *Found Culverts* Drawing D: 11C - 1 for more information.

\*\*All dimensions are approximate and shall be field verified.

\*\*\*N/A for culverts that do not have parapets/metal guardrail.



# 1 CULVERT MP 6.57

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana on upstream side.



Backside view of upstream / Hana corner of CRM parapet.

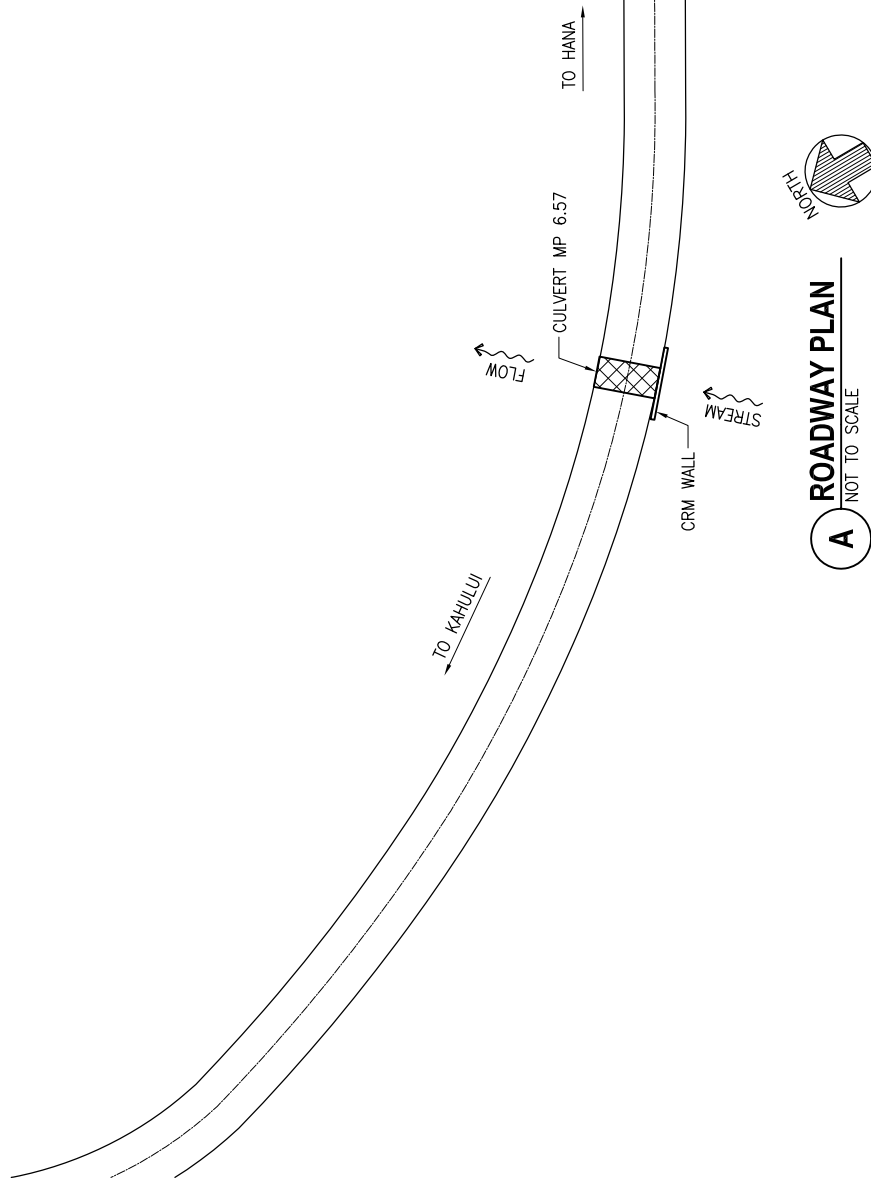
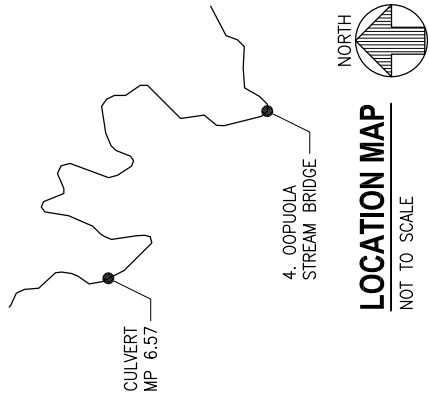
**1 CULVERT MP 6.57****C**

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



24" diameter RCP outlet at downstream side.

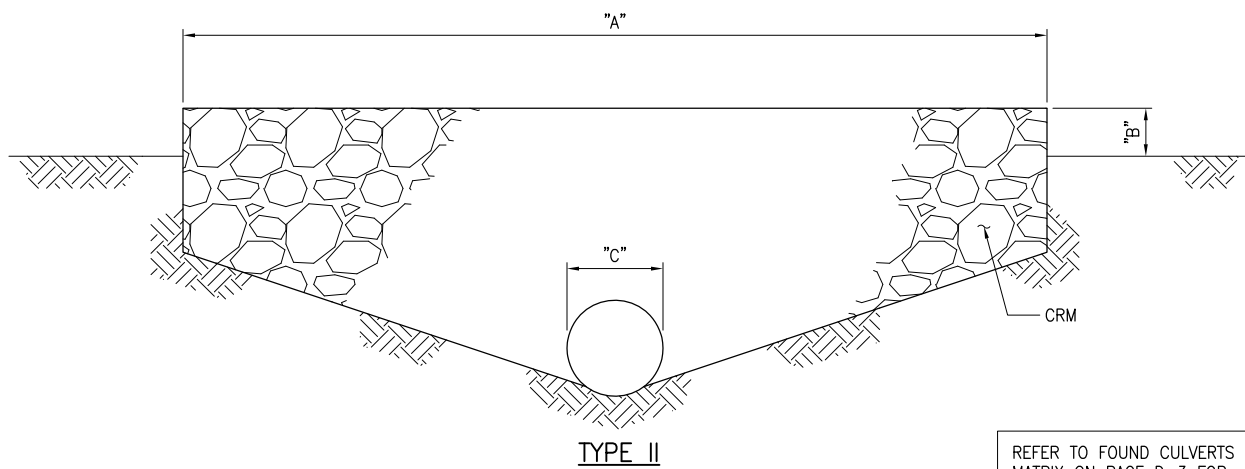
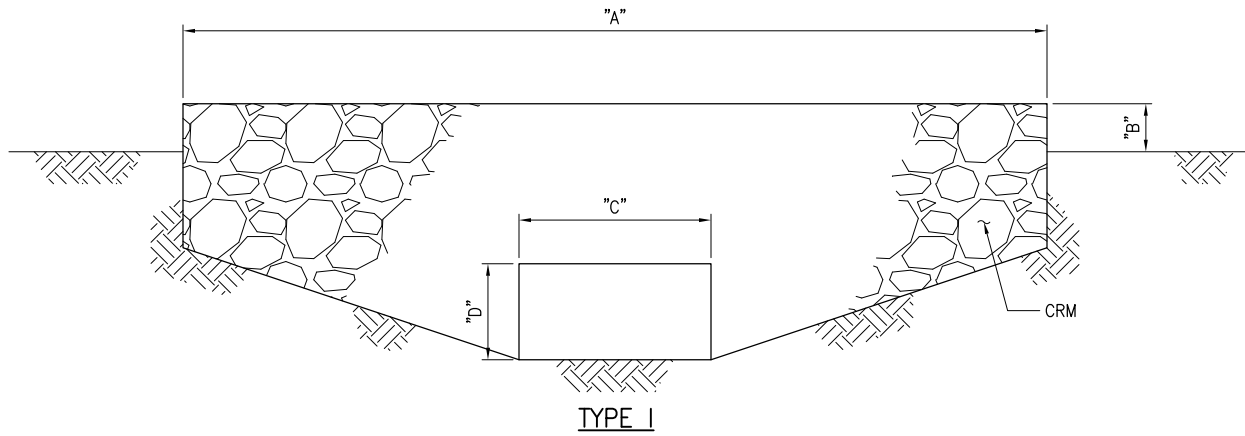




Drawing D: 1C-1

2015

CULVERT MP 6.57



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

### 3 CULVERT MP 9.13

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of upstream CRM parapet looking upstream.



View of downstream CRM parapet looking south-east.

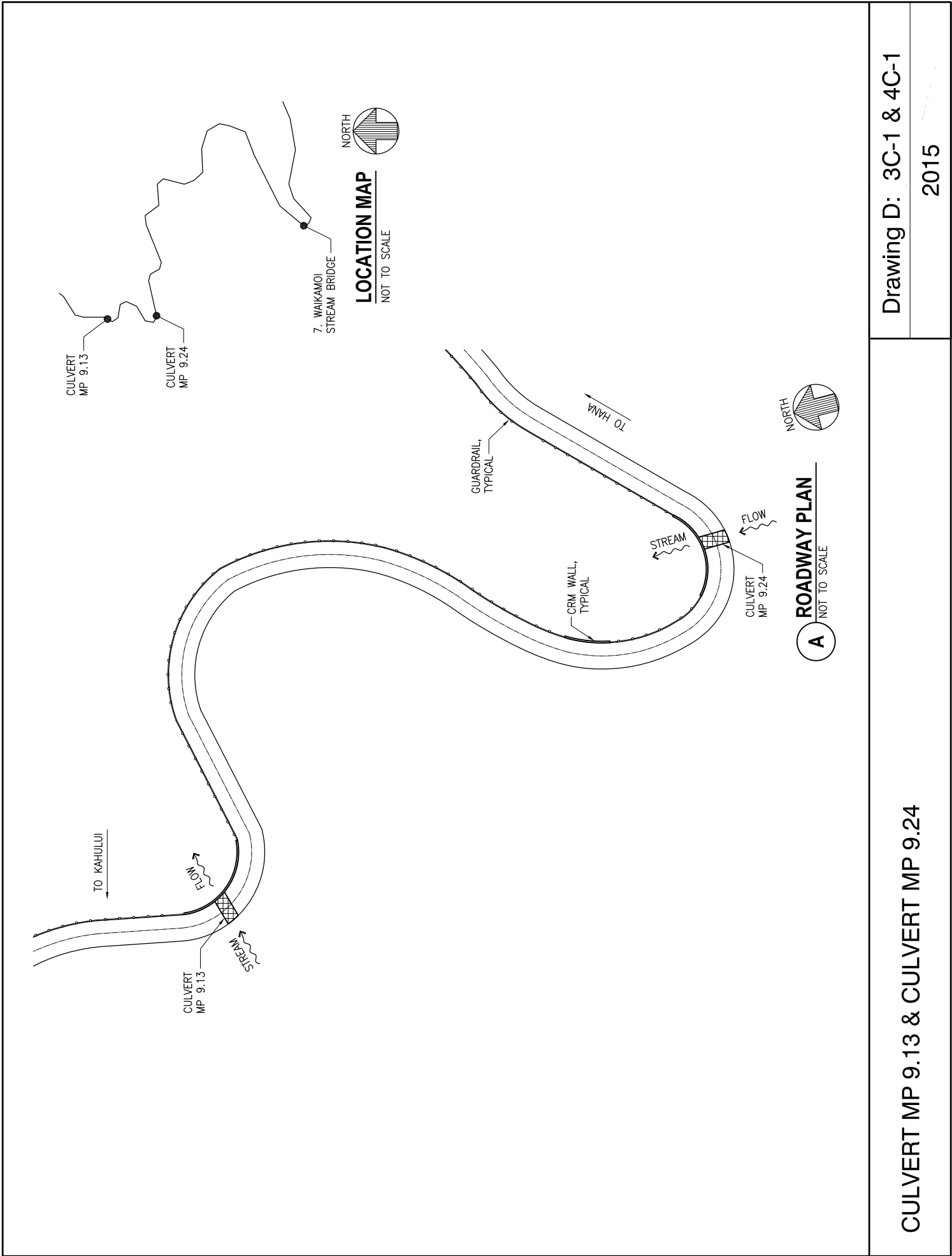


**3 CULVERT MP 9.13****C**

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



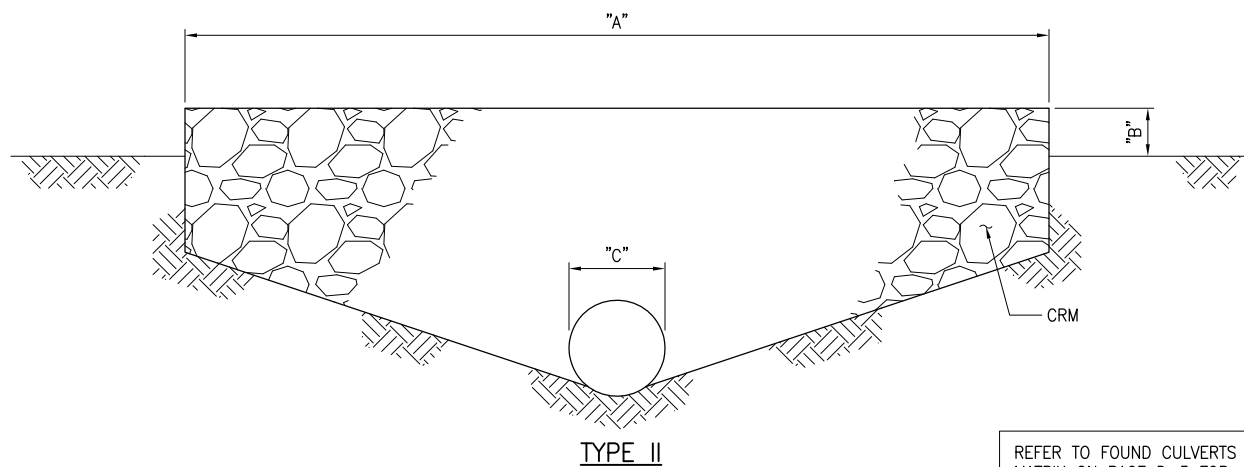
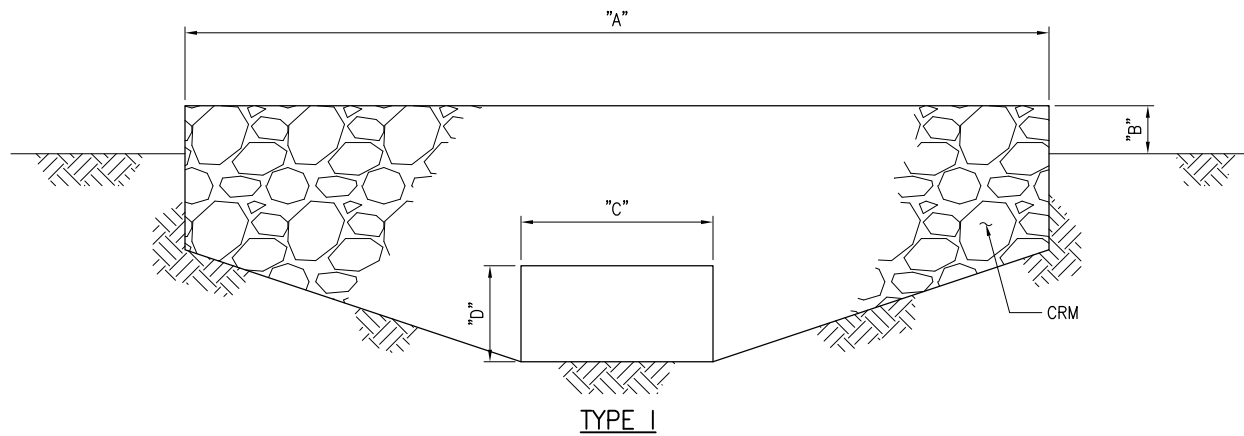
24" diameter RCP inlet at upstream side.



CULVERT MP 9.13 & CULVERT MP 9.24

Drawing D: 3C-1 & 4C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

4 C	<b>CULVERT MP 9.24</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement




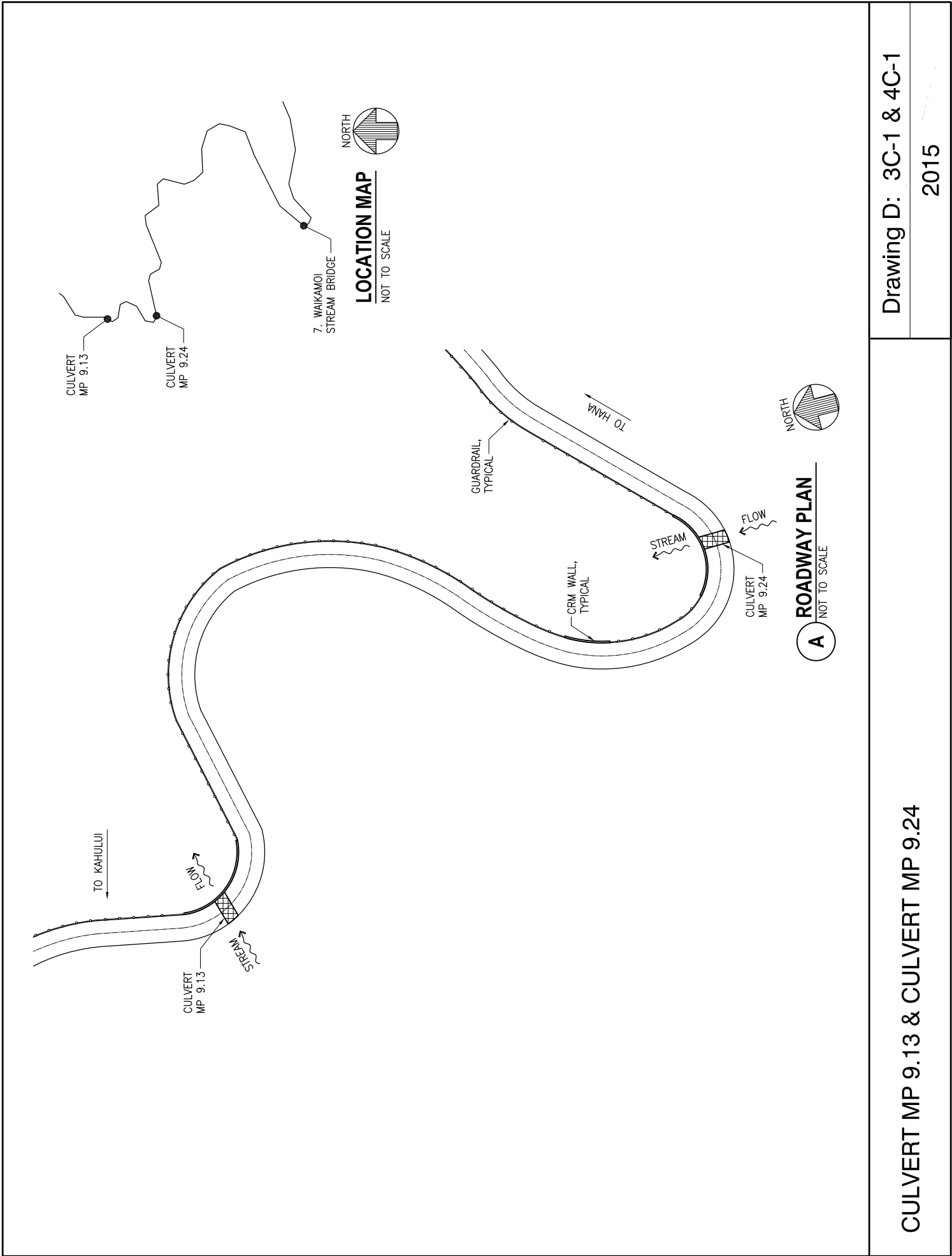
Kahului approach looking toward Hana.



Upstream elevation view of culvert.



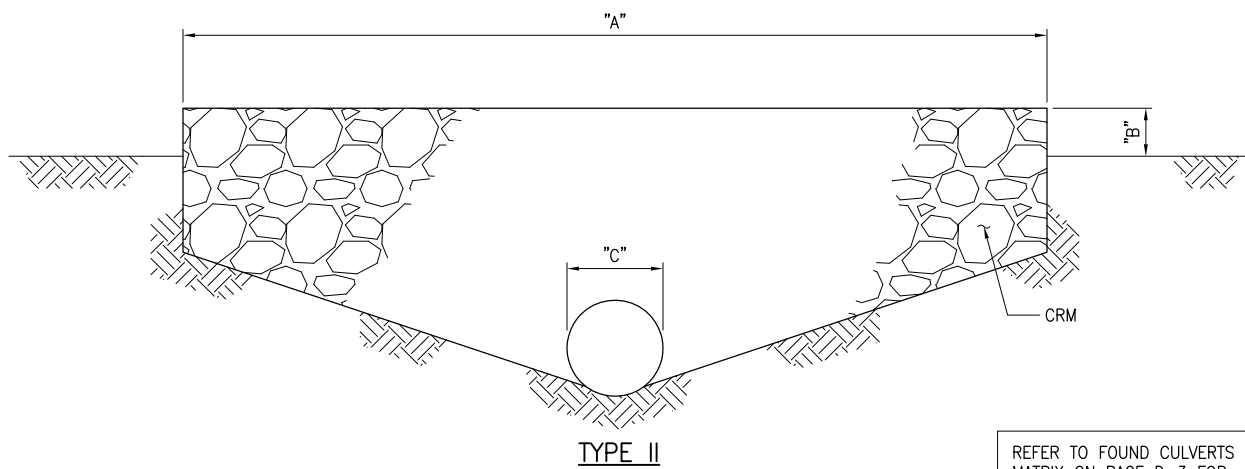
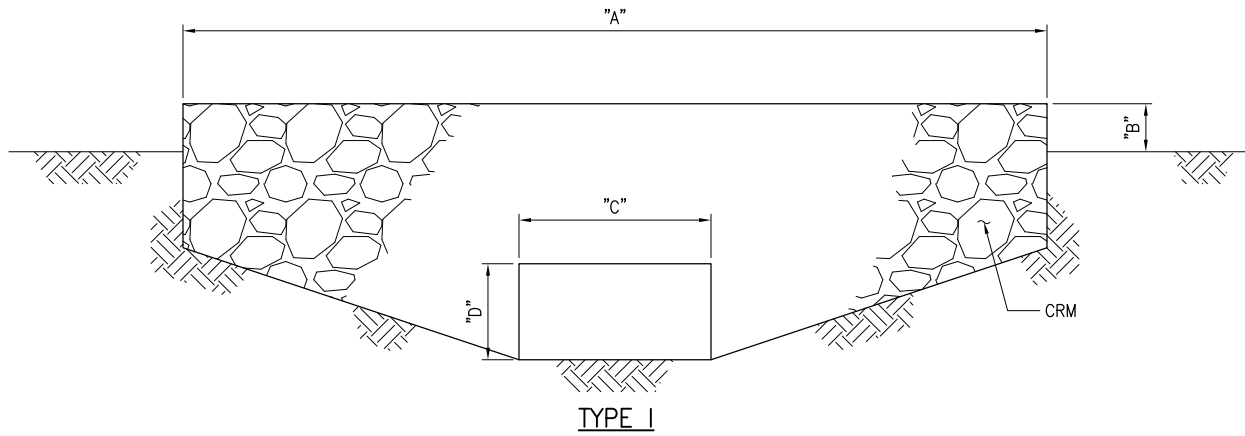
4 C	<b>CULVERT MP 9.24</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations: <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			
				
<p>Close-up of culvert opening at upstream side.</p>				



CULVERT MP 9.13 & CULVERT MP 9.24

Drawing D: 3C-1 & 4C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** TYPICAL ELEVATION  
NOT TO SCALE



# 5 CULVERT MP 10.18

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.

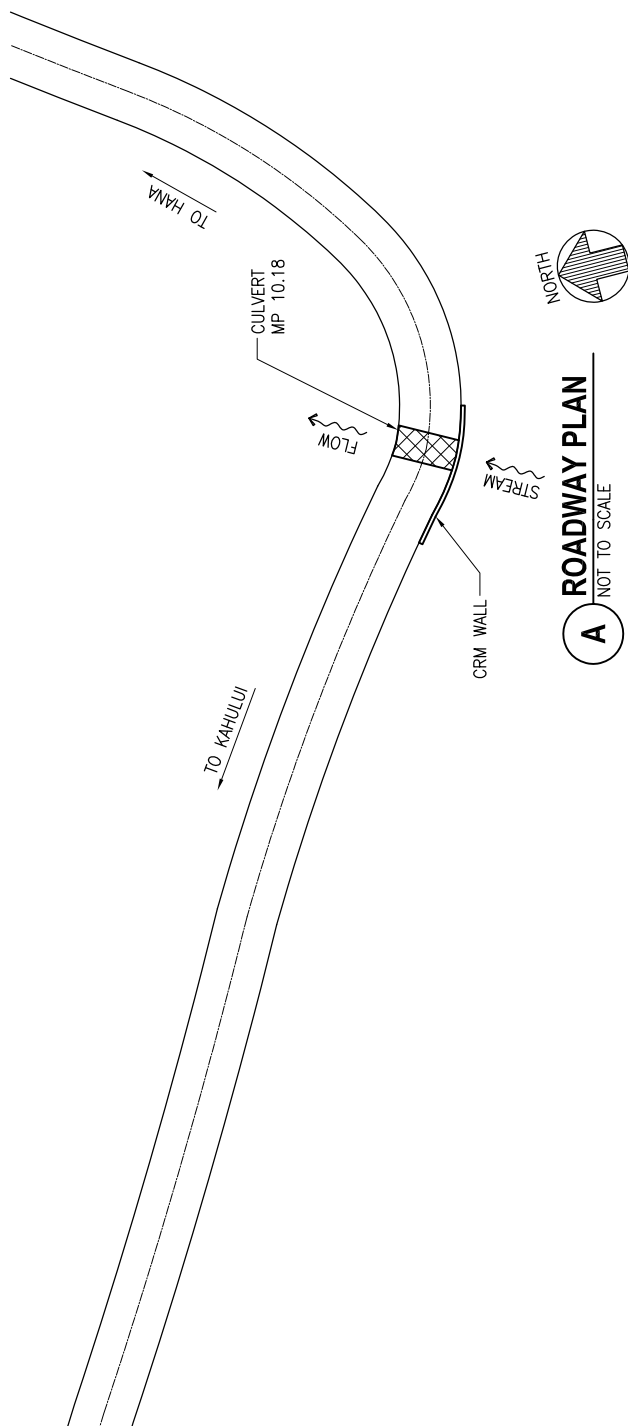
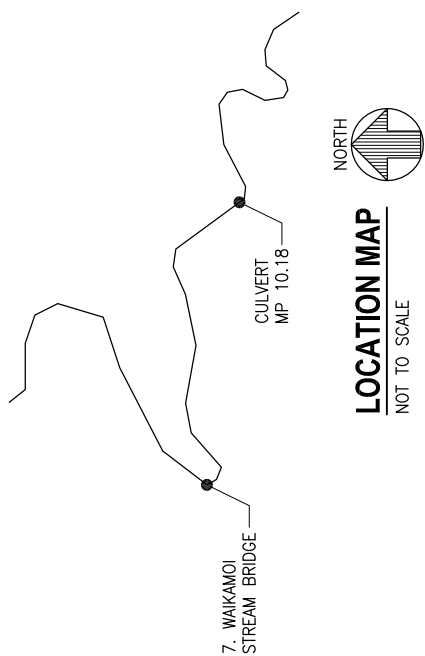
# 5 CULVERT MP 10.18

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



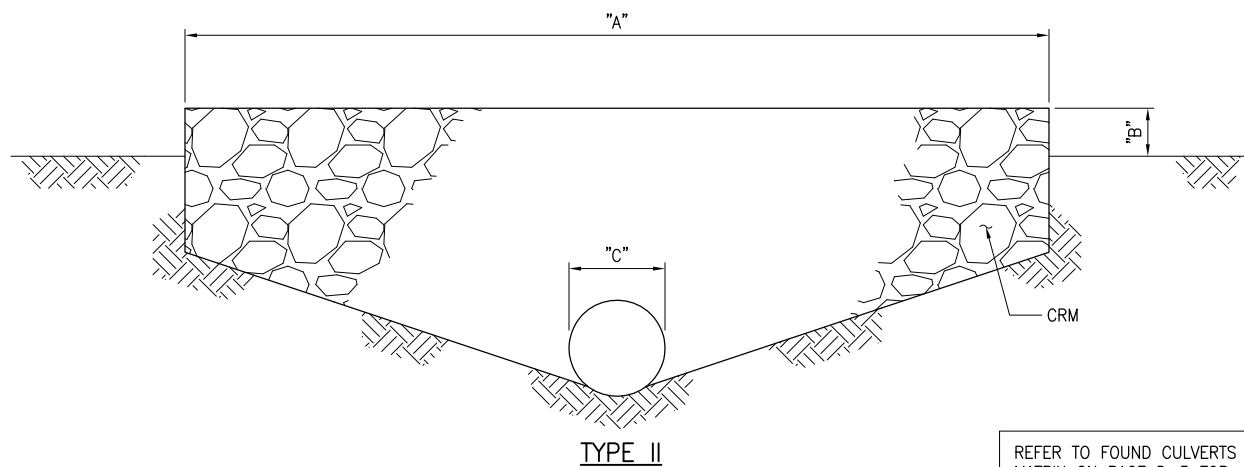
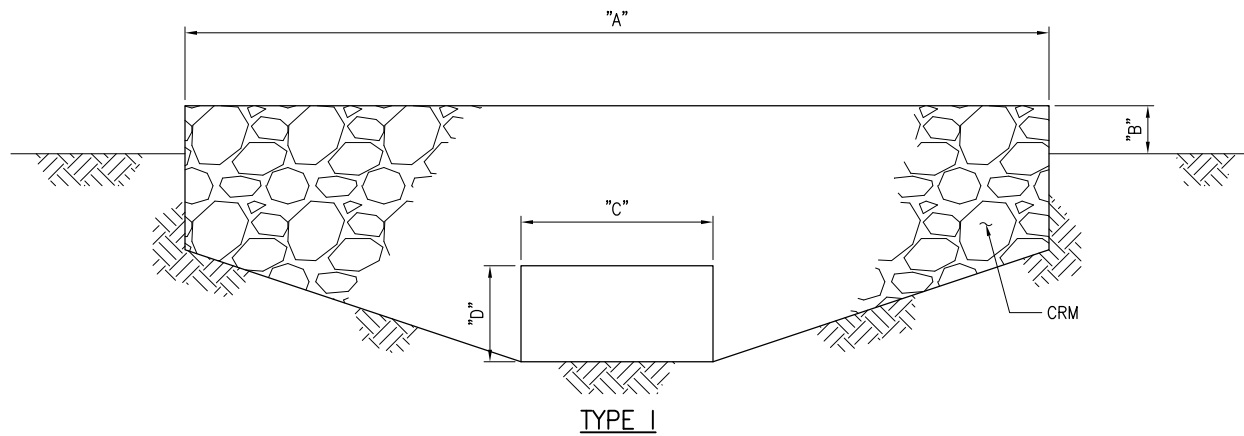
Upstream view through concrete box culvert.



Drawing D: 5C-1

2015

CULVERT MP 10.18



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



# 6 CULVERT MP 10.48

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.

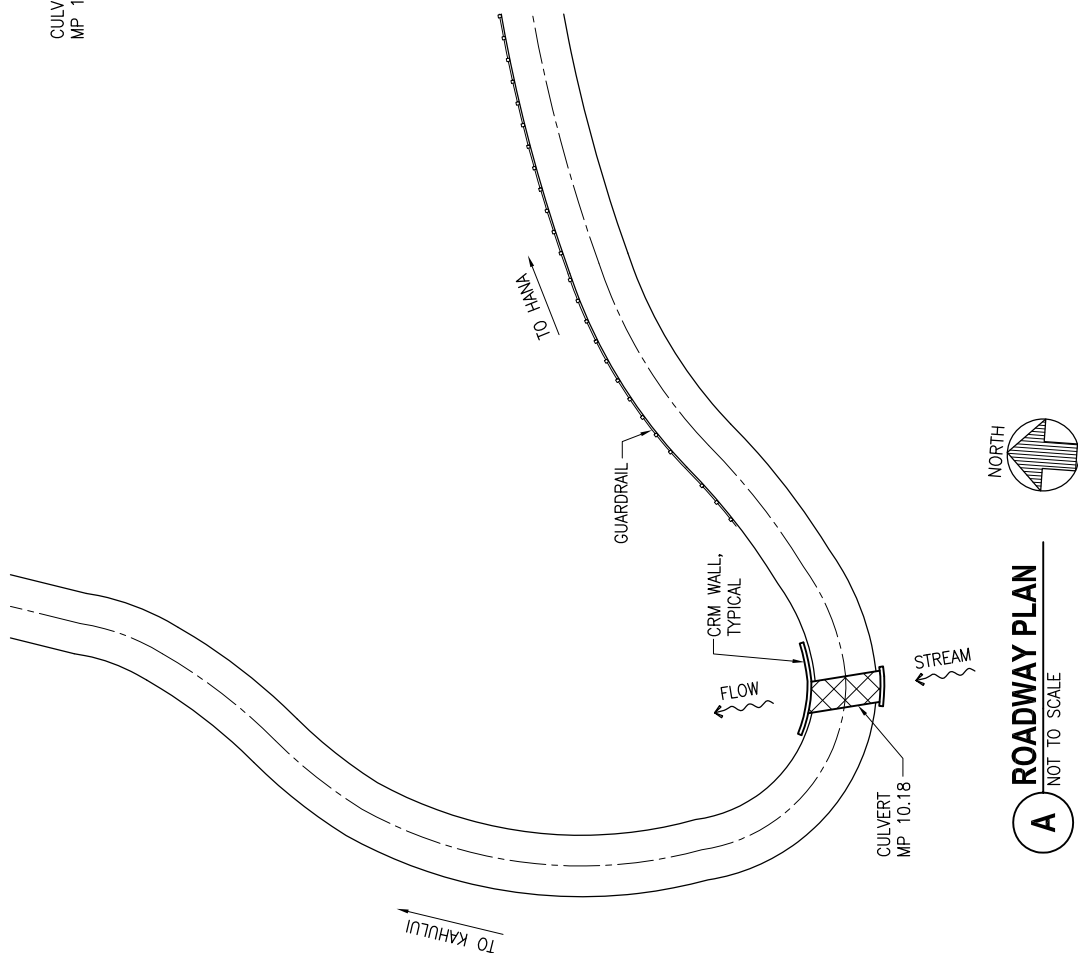
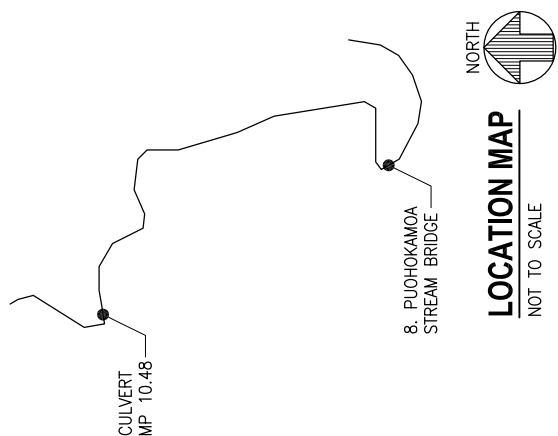


Backside view of upstream CRM headwall / parapet.

6 C	<b>CULVERT MP 10.48</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations: <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



Close-up view of upstream culvert opening.

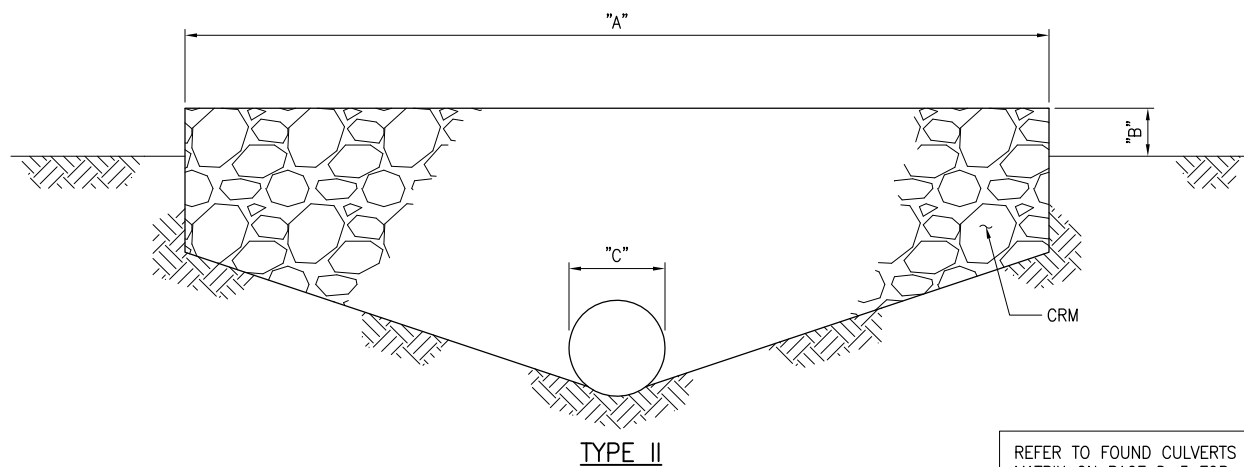
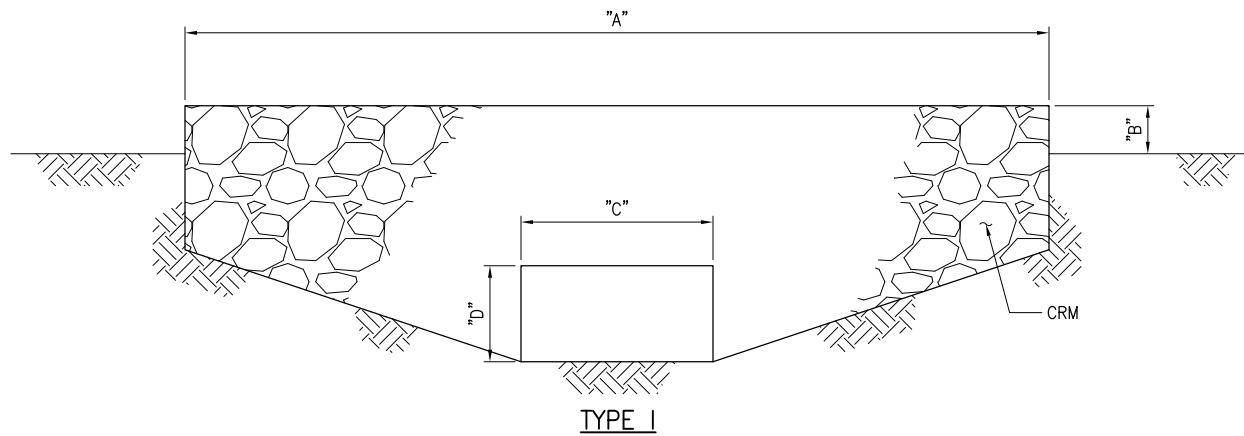


Drawing D: 6C-1

2015

CULVERT MP 10.48





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

# 7 CULVERT MP 11.82

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.

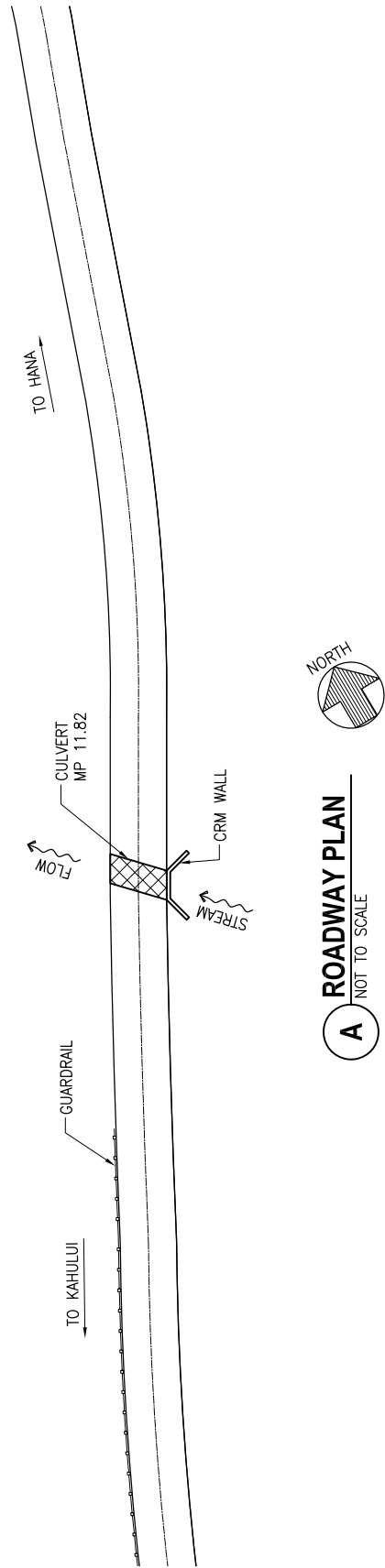
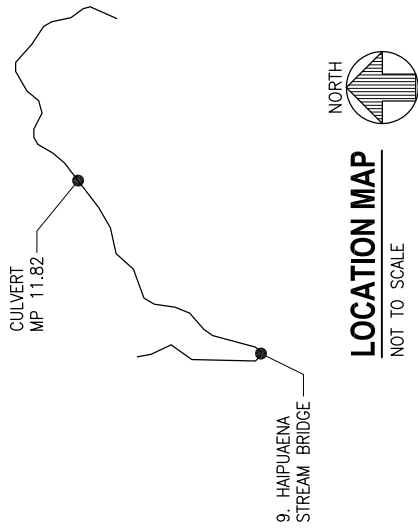
# 7 CULVERT MP 11.82

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



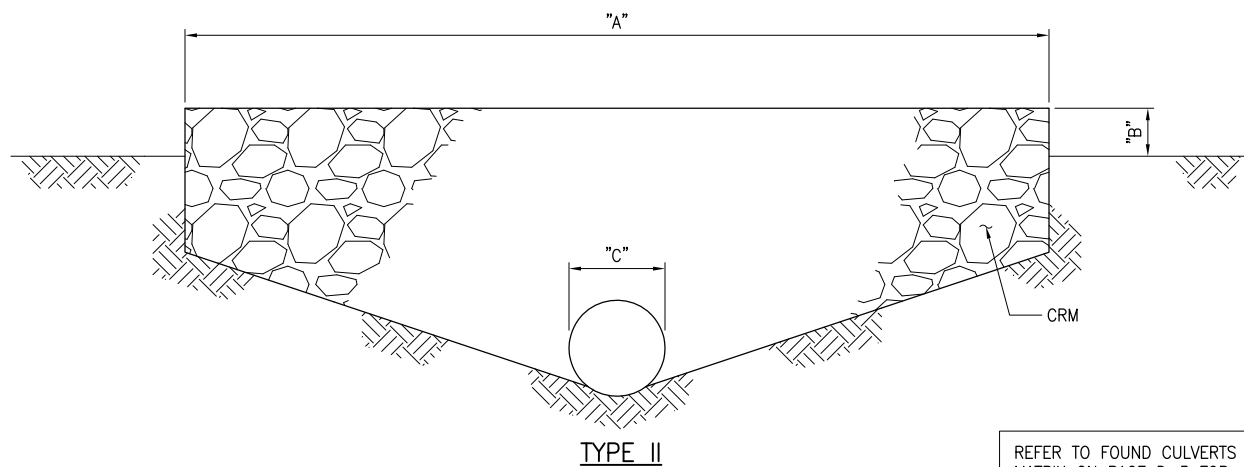
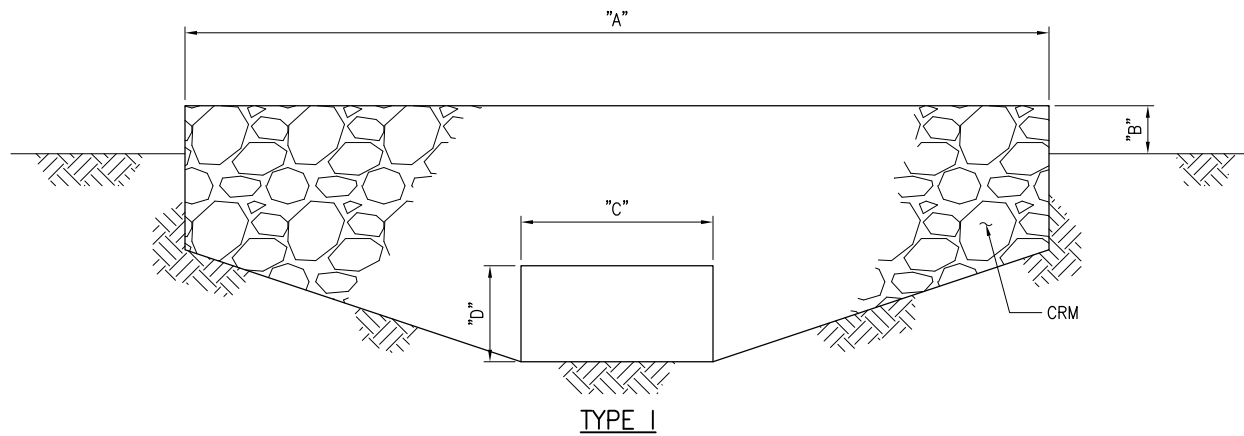
24" diameter RCP inlet at upstream side.



Drawing D: 7C-1

2015

CULVERT MP 11.82



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



# 8 CULVERT MP 12.12

C

Bridge Number:	N/A		Island:	Maui	
Date of Construction:	Unknown		Route:	Hana Highway	
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement	



Kahului approach looking toward Hana.



View of upstream CRM parapet.

# 8 CULVERT MP 12.12

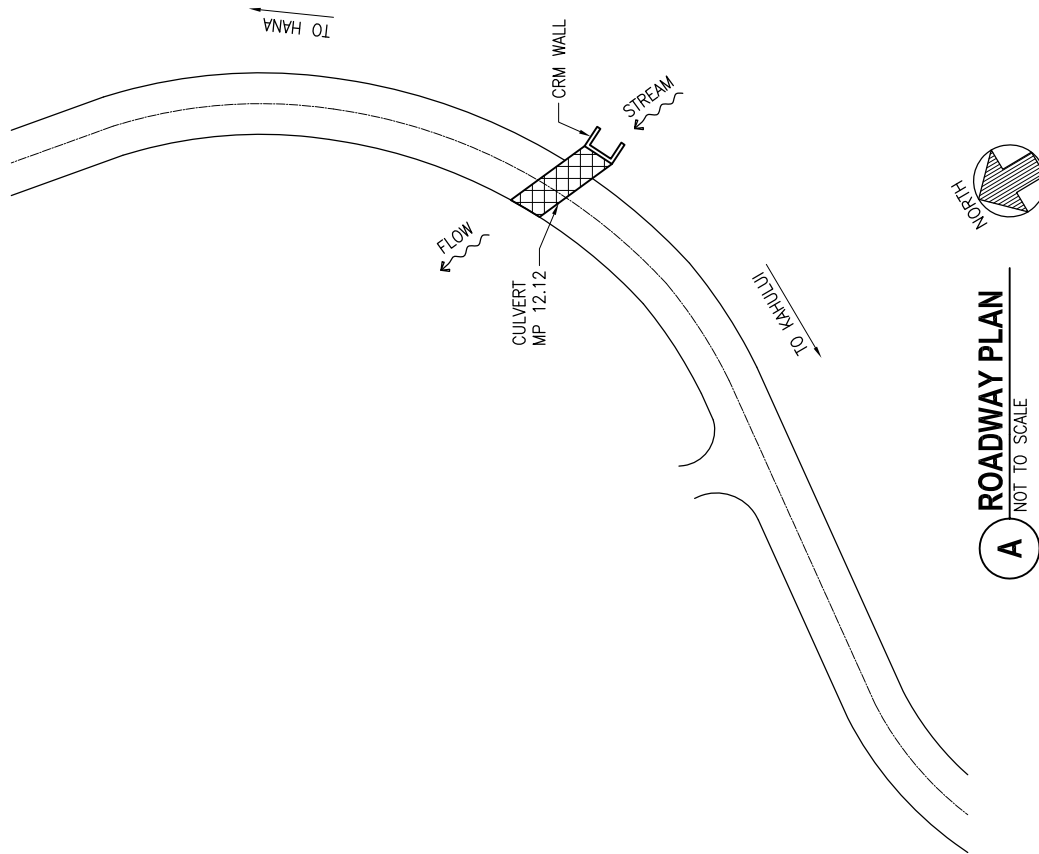
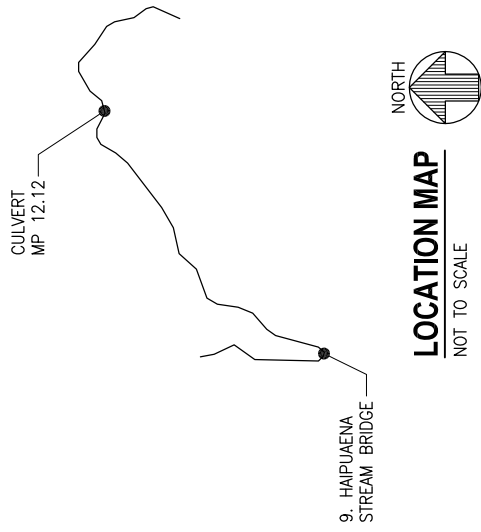
C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of upstream CRM headwall / parapet and culvert inlet.

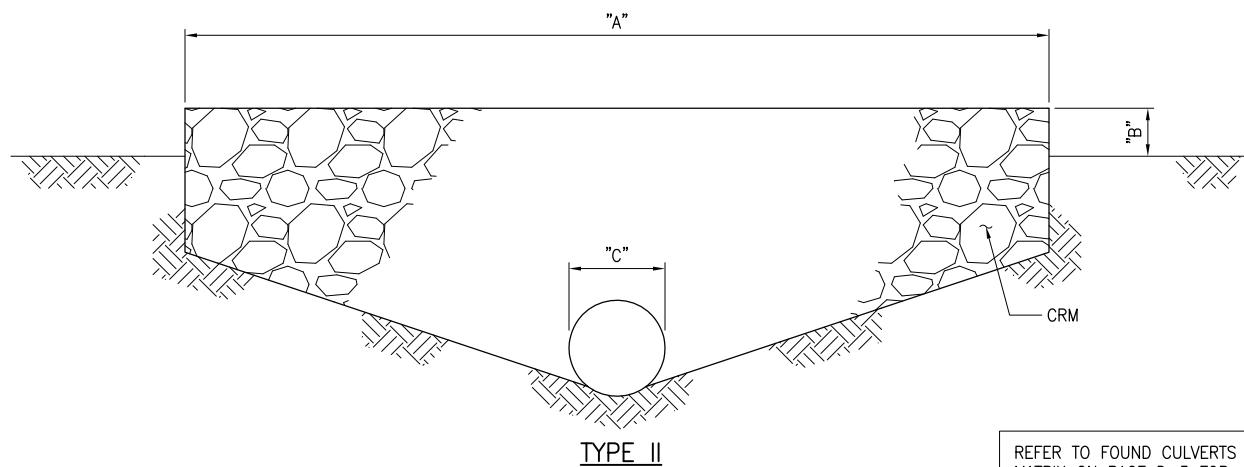
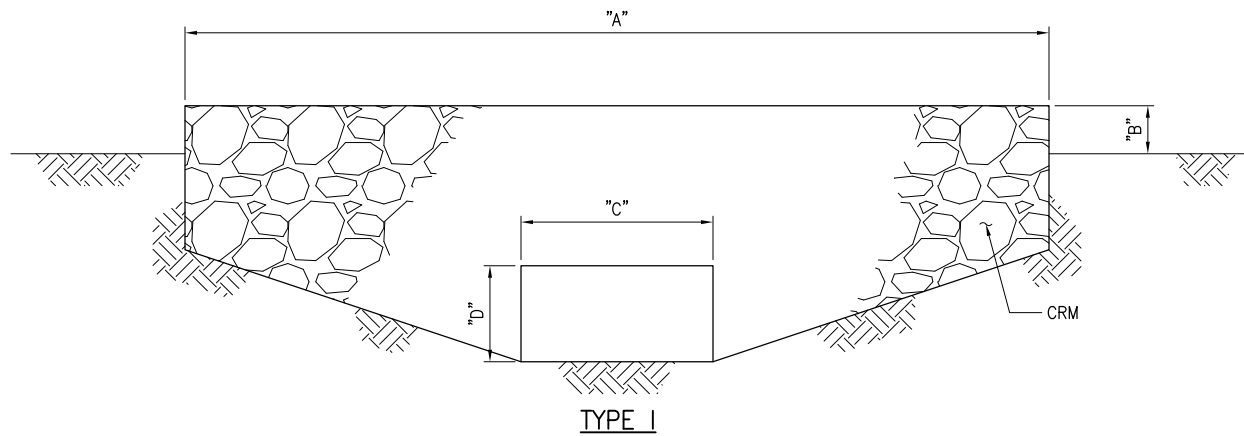




Drawing D: 8C-1

2015

CULVERT MP 12.12



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

# 9 CULVERT MP 12.65

C

Bridge Number:	N/A			Island:	Maui		
Date of Construction:	Unknown			Route:	Hana Highway		
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement			



Kahului approach looking toward Hana.

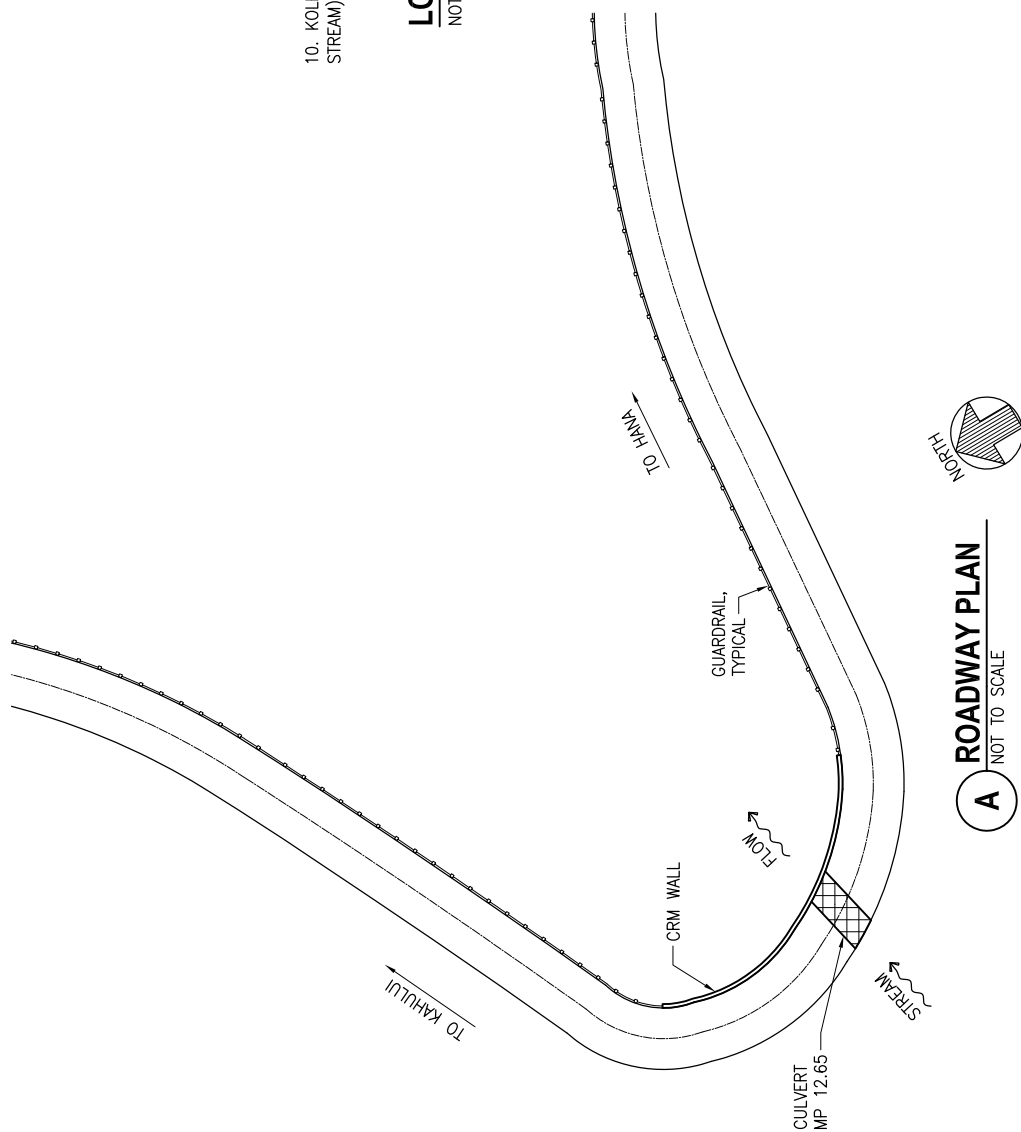
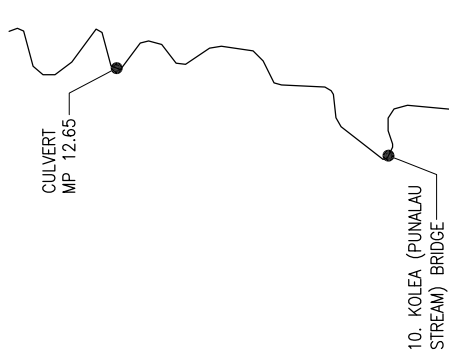


View of downstream CRM parapet looking south-east.

9 C	<b>CULVERT MP 12.65</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



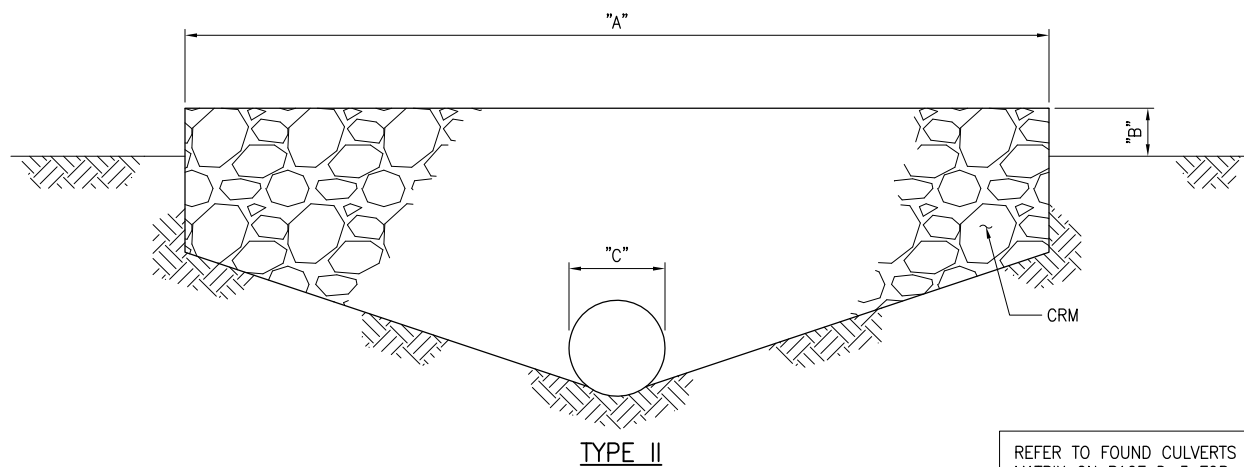
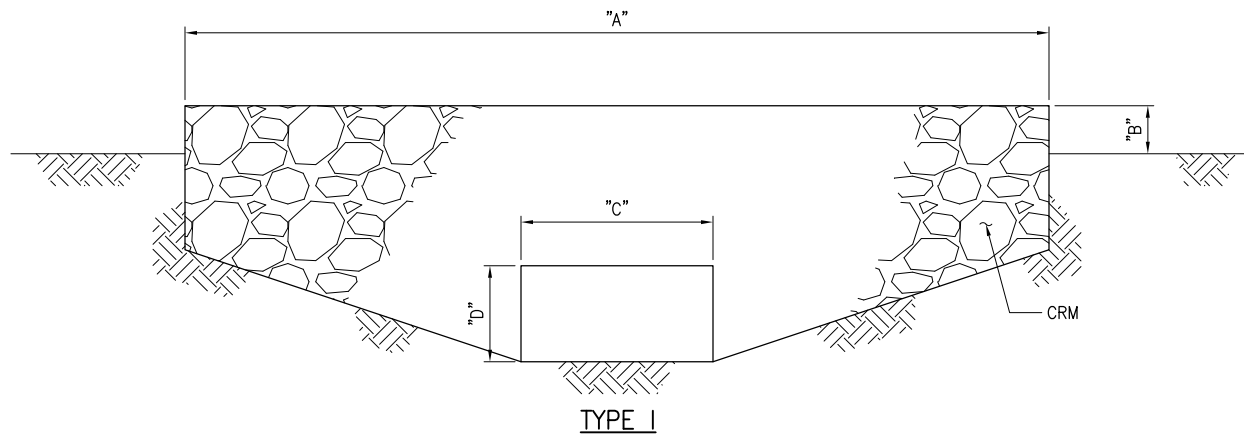
24" diameter RCP inlet at upstream side.



Drawing D: 9C-1

2015

CULVERT MP 12.65



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



10 C	<b>CULVERT MP 14.63</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream metal guardrail.



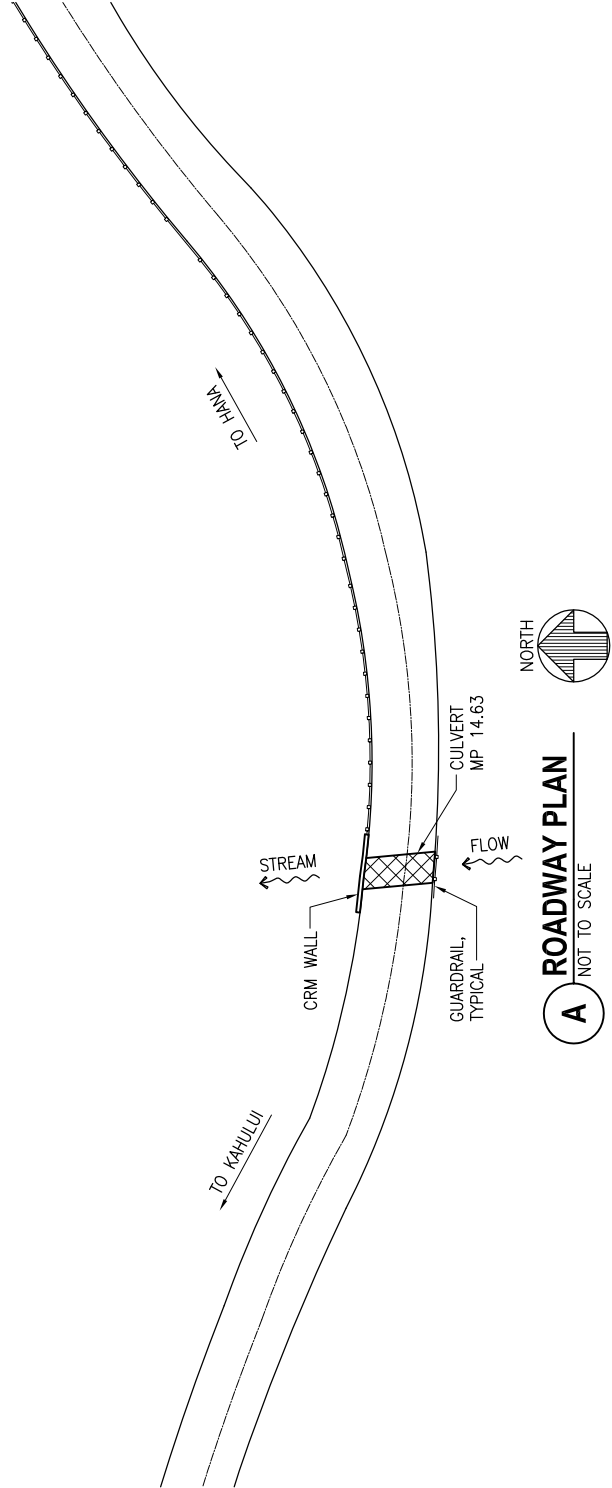
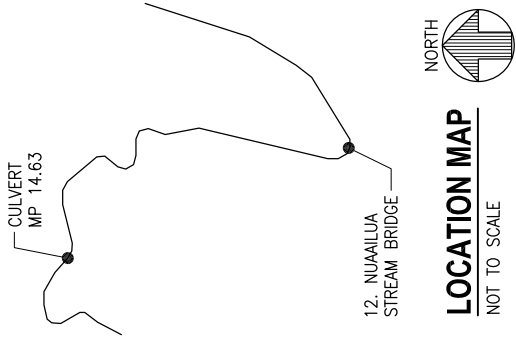
10 C	<b>CULVERT MP 14.63</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of downstream CRM parapet.



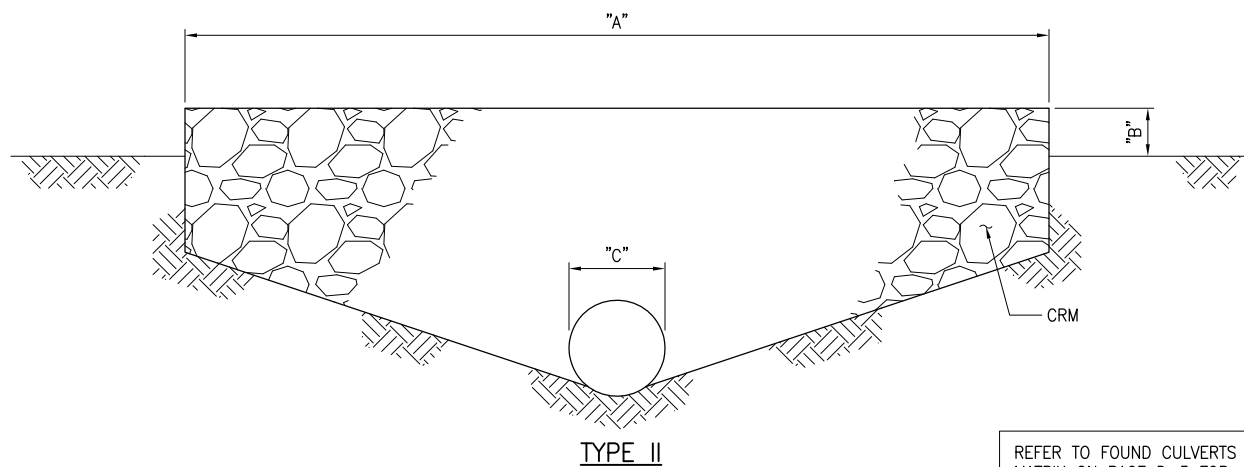
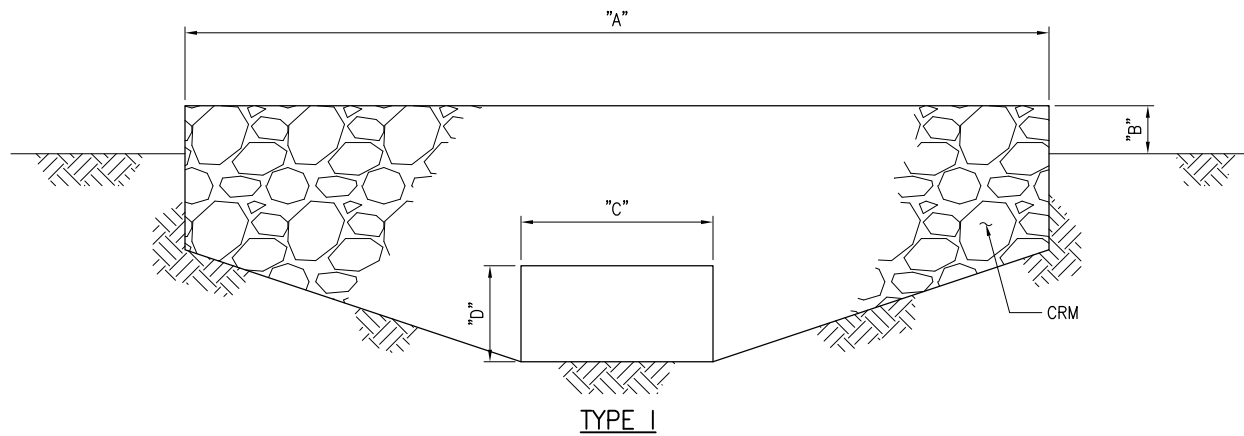
View through culvert from the upstream end.



Drawing D: 10C-1

2015

CULVERT MP 14.63



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



11 C	<b>CULVERT MP 14.91</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.

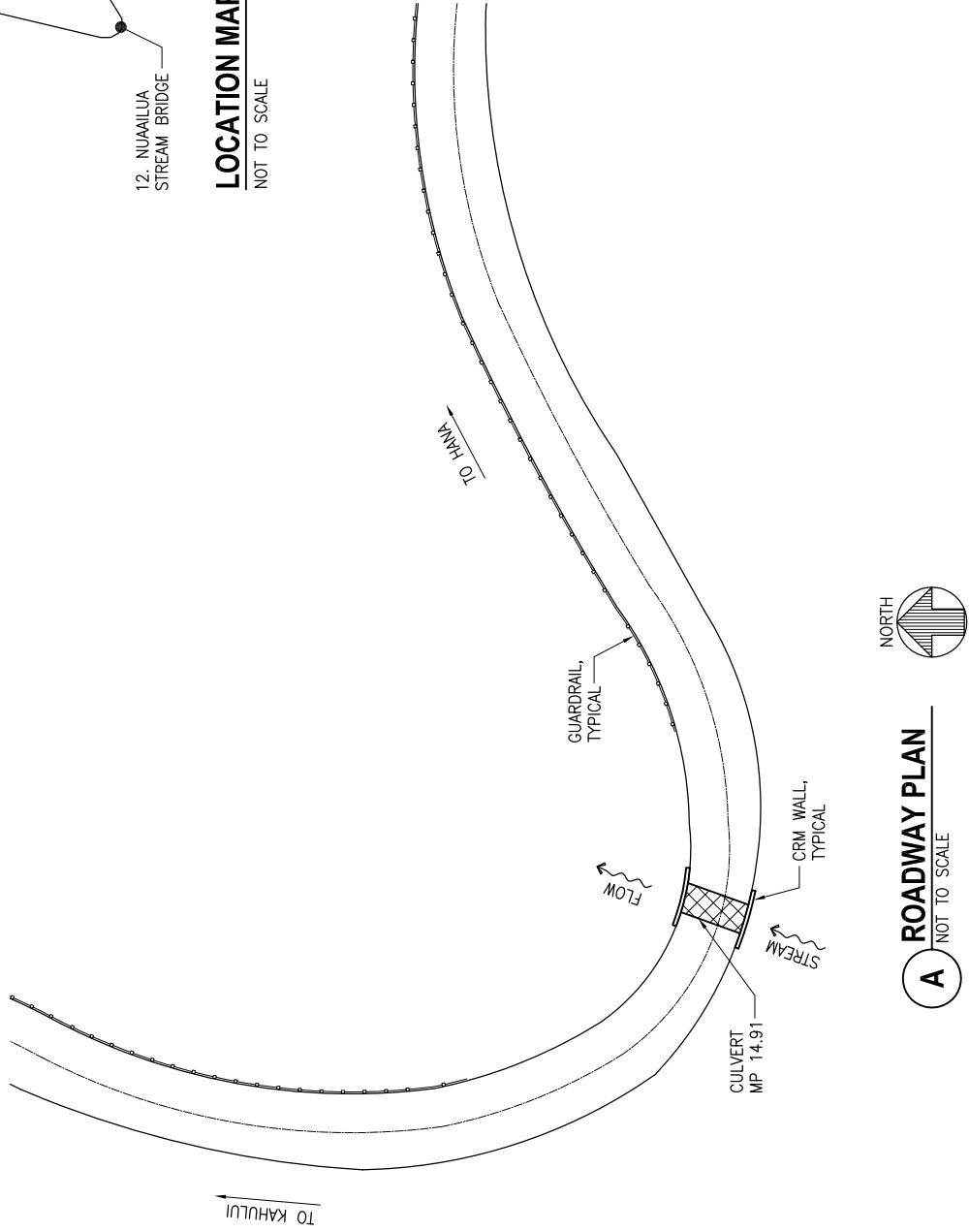
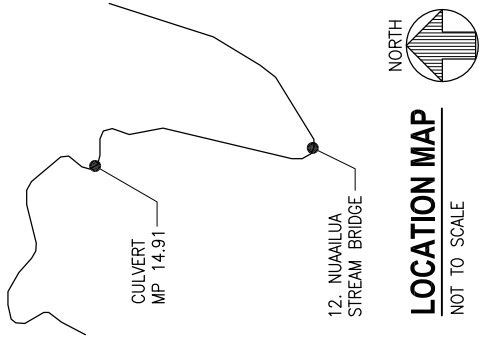


View of upstream CRM parapet.

11 C	<b>CULVERT MP 14.91</b>				
	<b>Bridge Number:</b>	N/A		<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown		<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement				



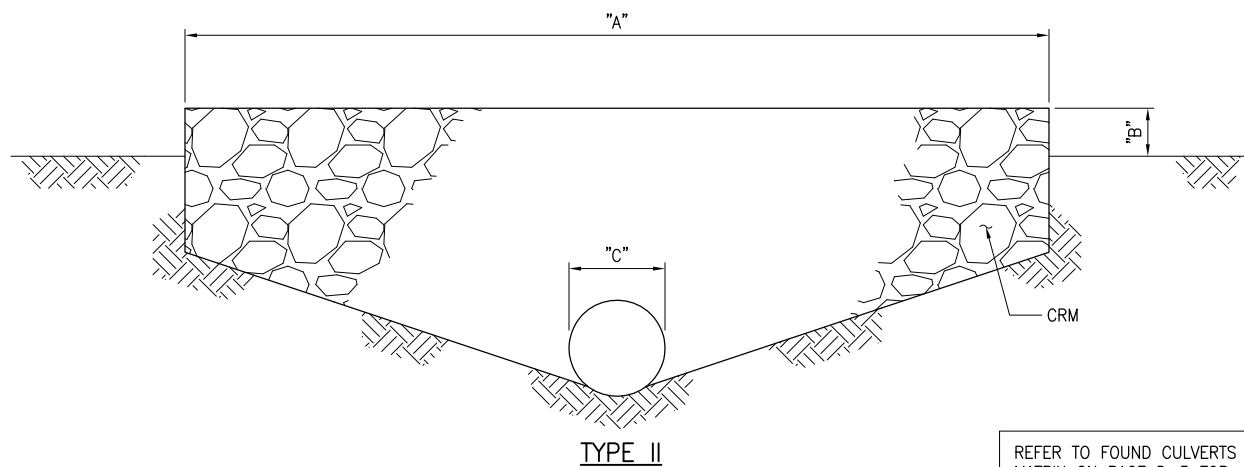
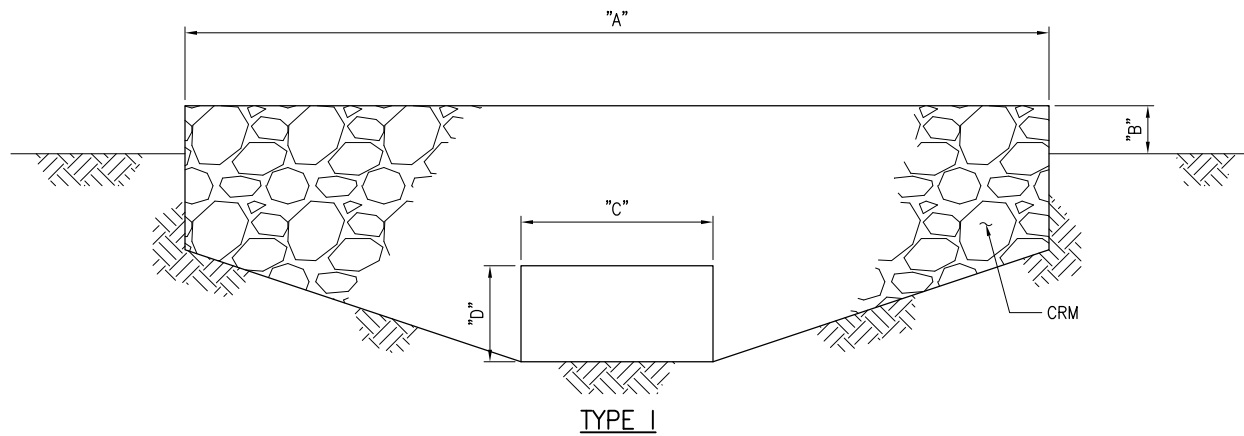
Upstream elevation of CRM parapet. Note: Nothing could be seen per description on as-builts.



CULVERT MP 14.91

Drawing D: 11C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



12 C	<b>CULVERT MP 15.40</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.

12 C	<b>CULVERT MP 15.40</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



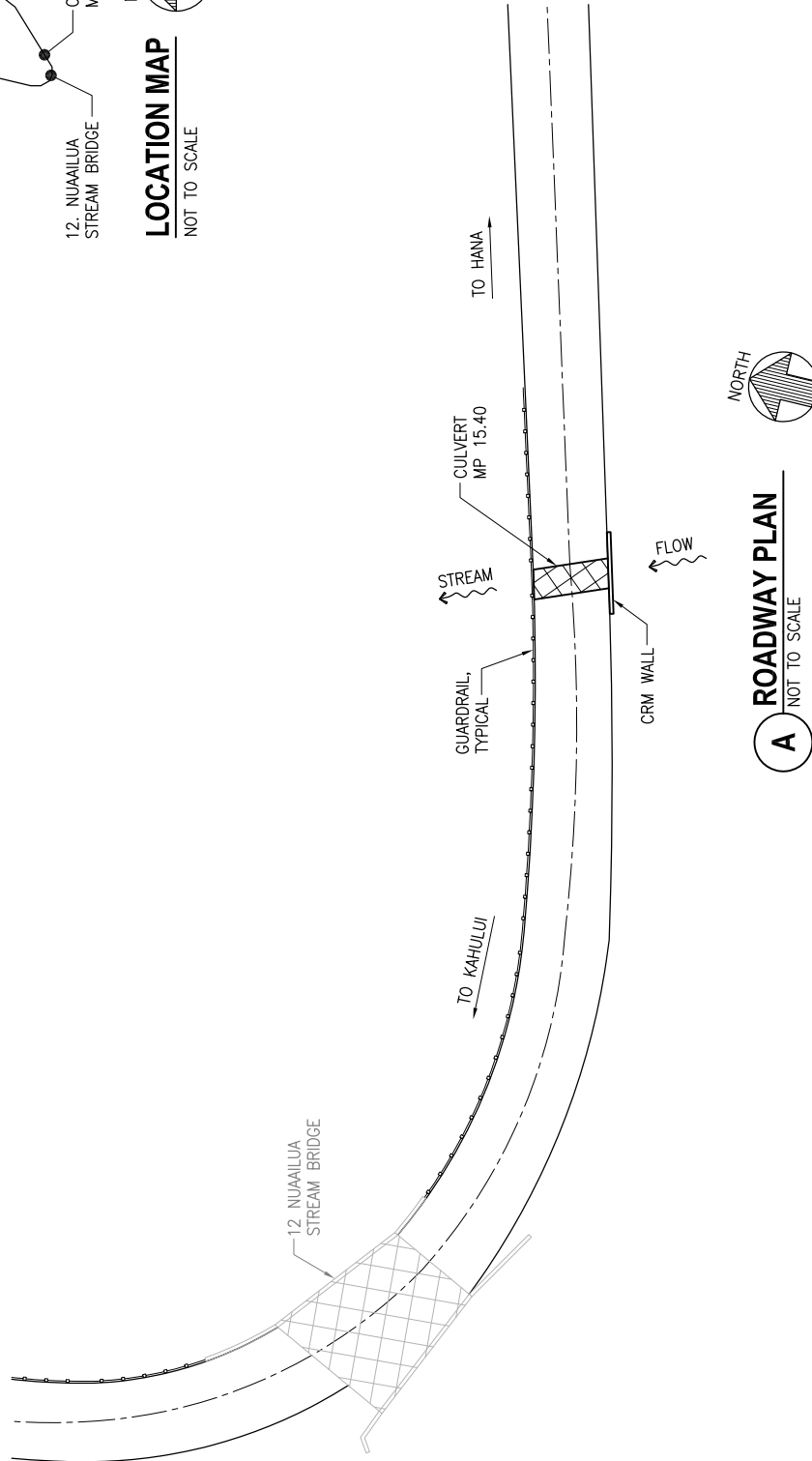
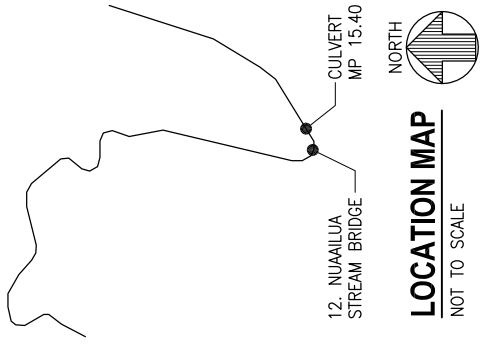
View of downstream metal guardrail.



RCP inlet

View of upstream CRM headwall / parapet and 24" diameter RCP inlet.

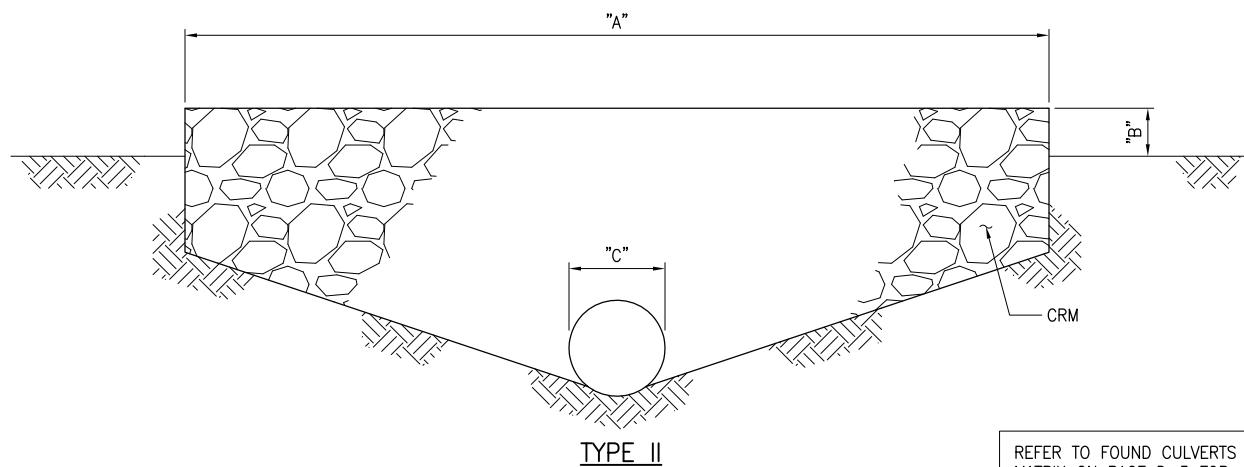
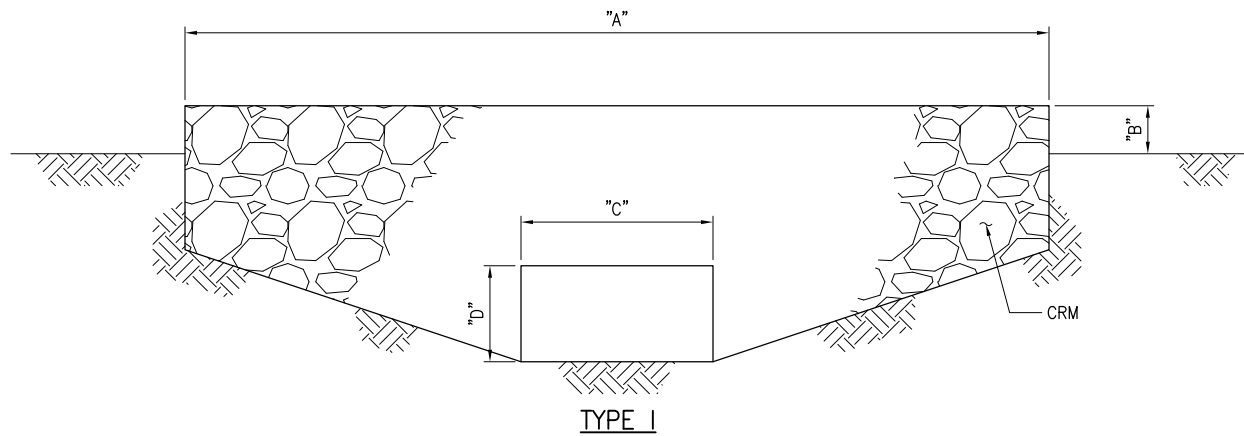




Drawing D: 12C-1

2015

CULVERT MP 15.40



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

<b>13</b> <b>C</b>	<b>CULVERT MP 16.06</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



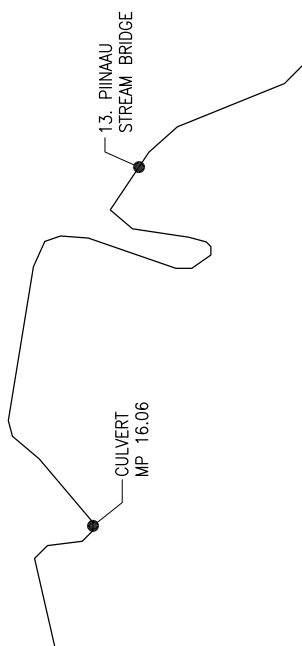
13 C	<b>CULVERT MP 16.06</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



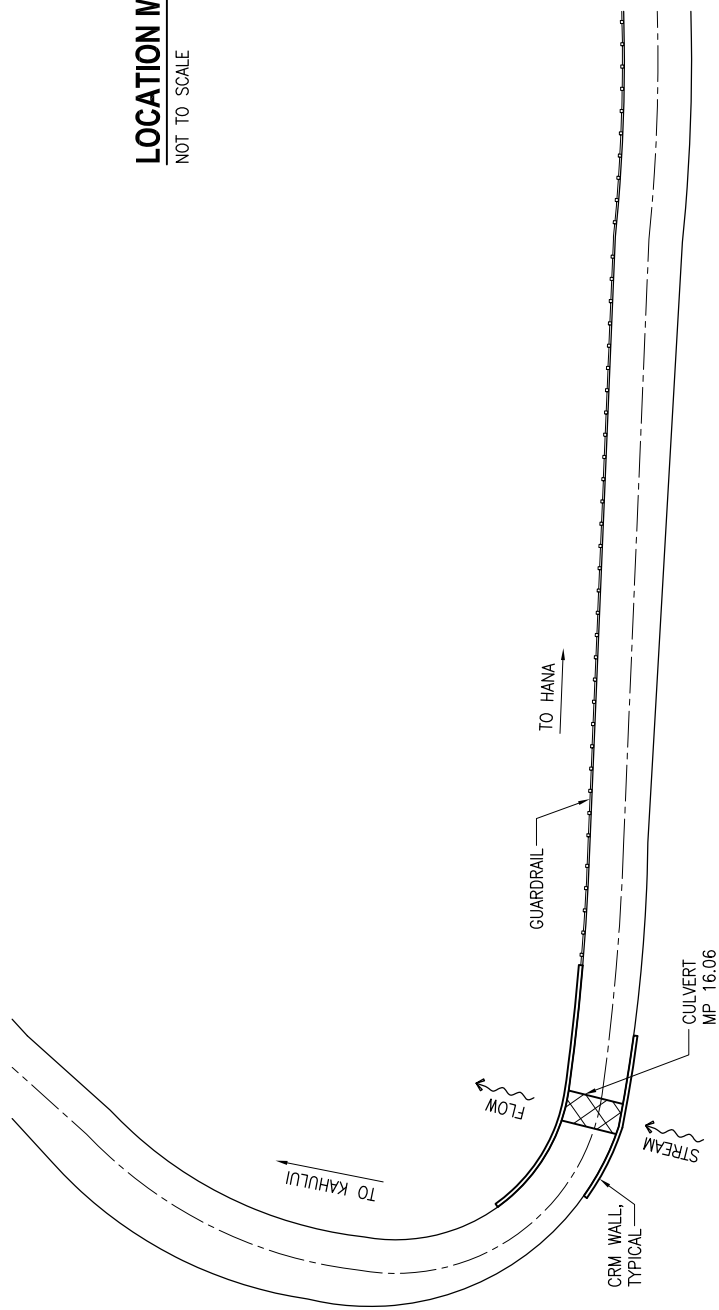
View of downstream CRM parapet.



View looking downstream through culvert.



**LOCATION MAP**  
NOT TO SCALE



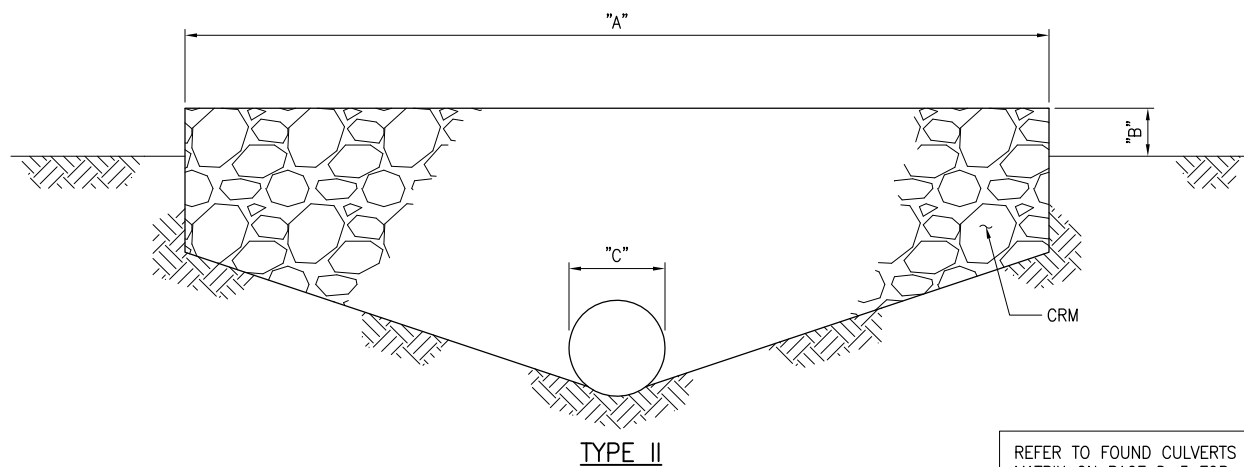
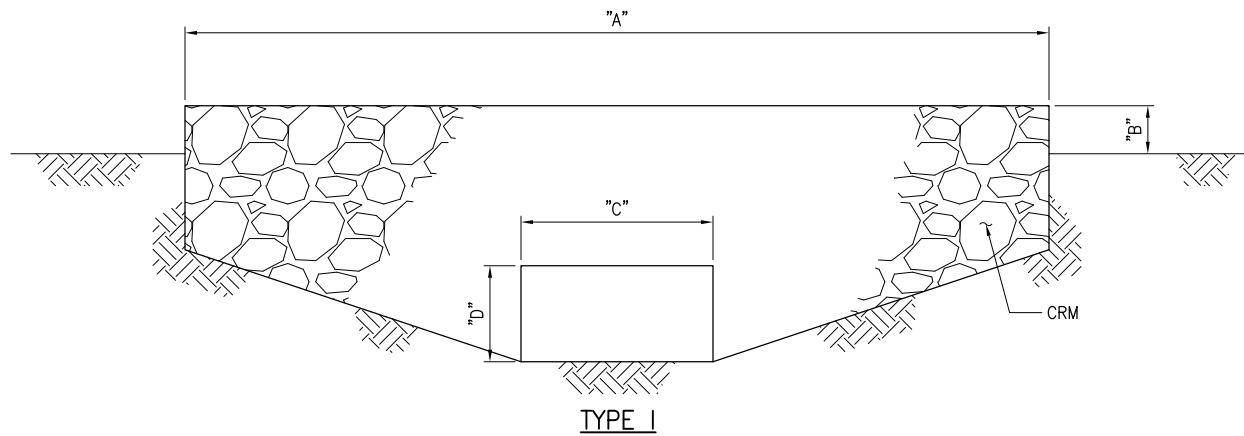
**A ROADWAY PLAN**  
NOT TO SCALE

Drawing D: 13C-1

2015

CULVERT MP 16.06





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

14 C	<b>CULVERT MP 17.03</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



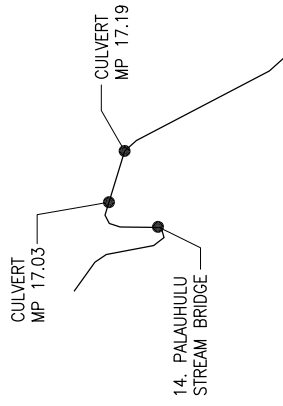
14 C	<b>CULVERT MP 17.03</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



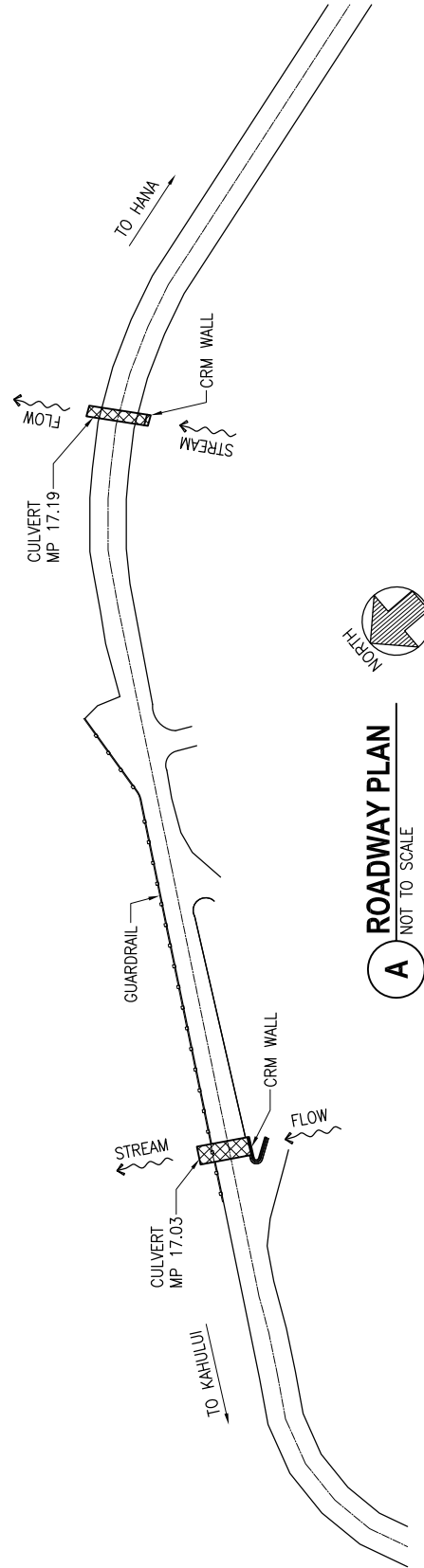
View of downstream metal guardrail.



24" diameter RCP inlet at upstream side. Upstream / Hana corner of CRM parapet is damaged.



**LOCATION MAP**  
NOT TO SCALE

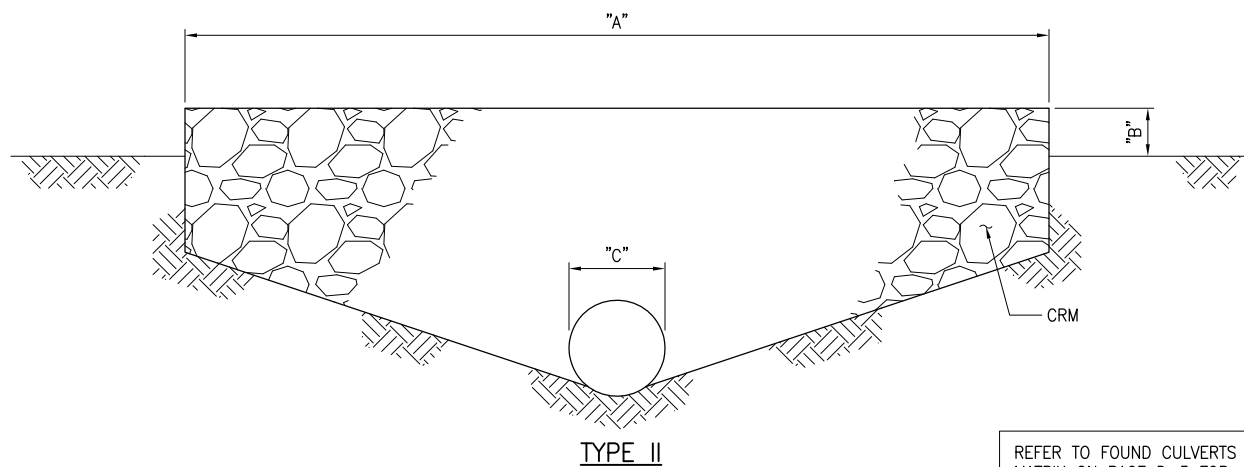
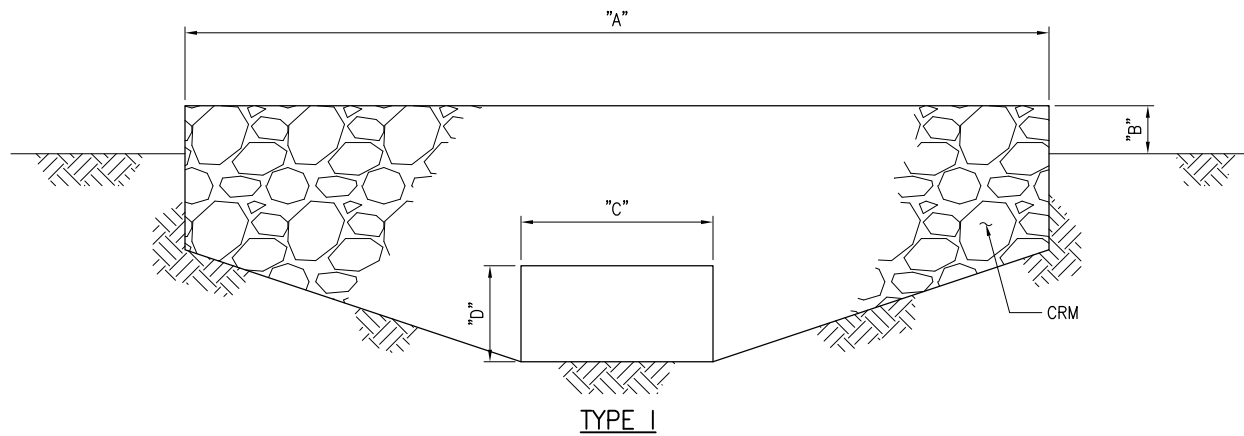


**A ROADWAY PLAN**  
NOT TO SCALE

CULVERT MP 17.03 & CULVERT MP 17.19

Drawing D: 14C-1 & 15C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



15 C	<b>CULVERT MP 17.19</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



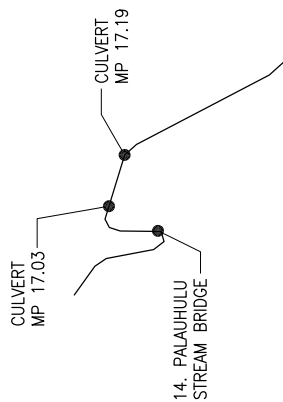
View of upstream CRM parapet.



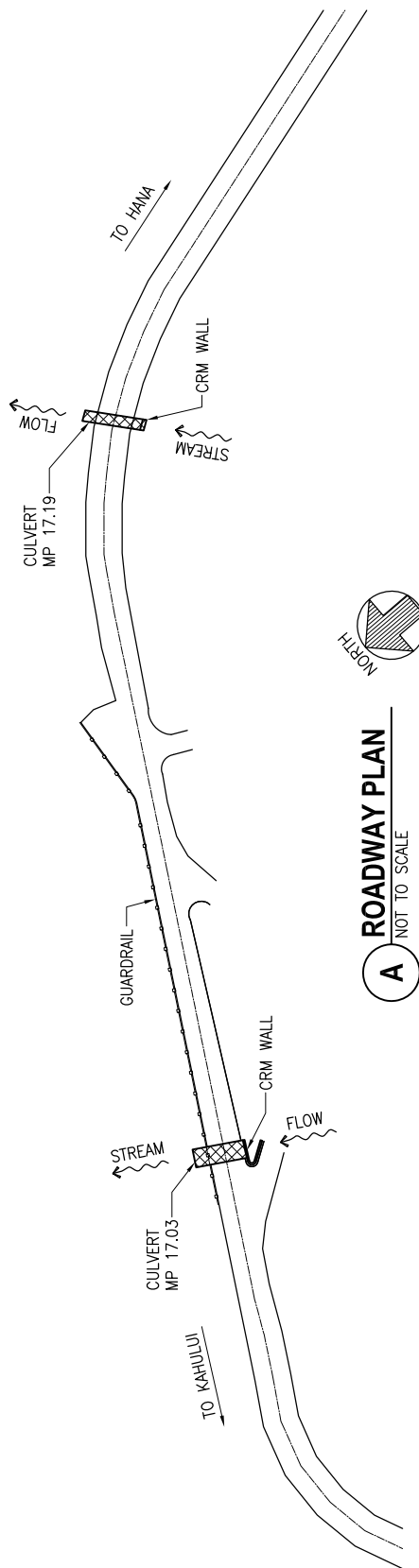
15 C	<b>CULVERT MP 17.19</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of upstream CRM headwall / parapet and 24" diameter RCP inlet.



**LOCATION MAP**  
NOT TO SCALE

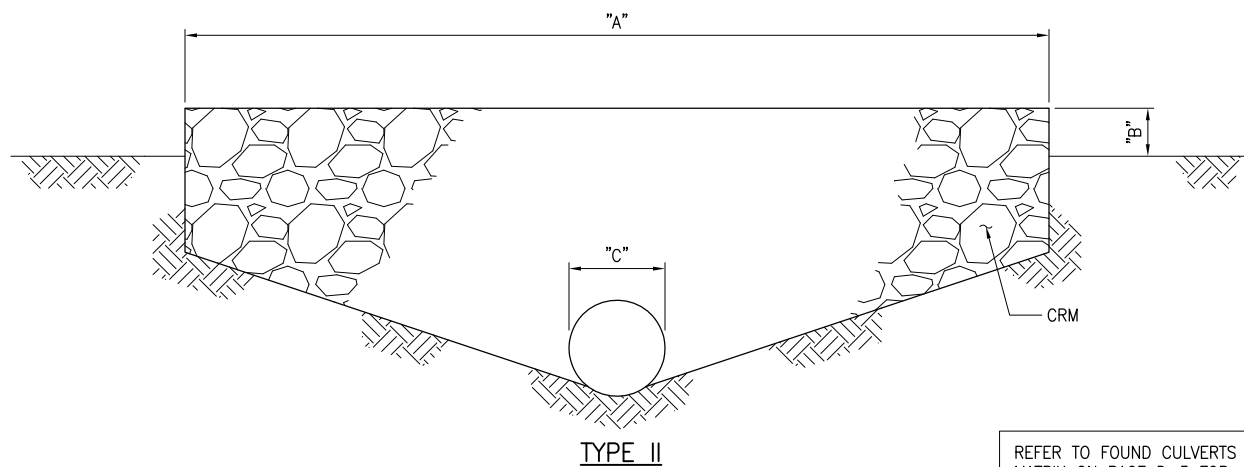
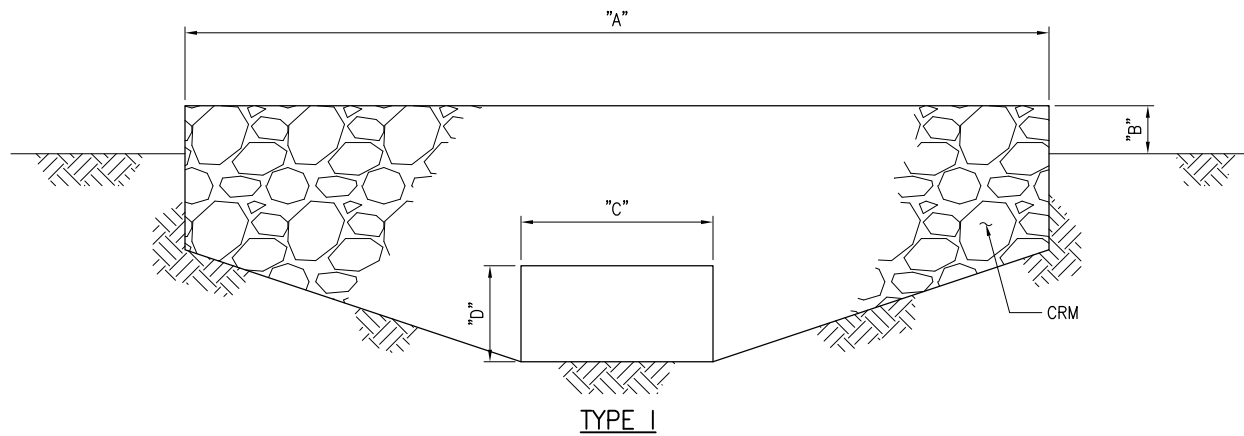


**A ROADWAY PLAN**  
NOT TO SCALE

Drawing D: 14C-1 & 15C-1

2015

CULVERT MP 17.03 & CULVERT MP 17.19



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

16 C	<b>CULVERT MP 17.27</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of chains and posts above upstream culvert.



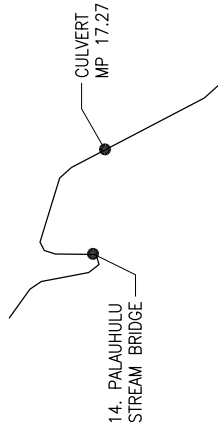
16 C	<b>CULVERT MP 17.27</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream CRM parapet.

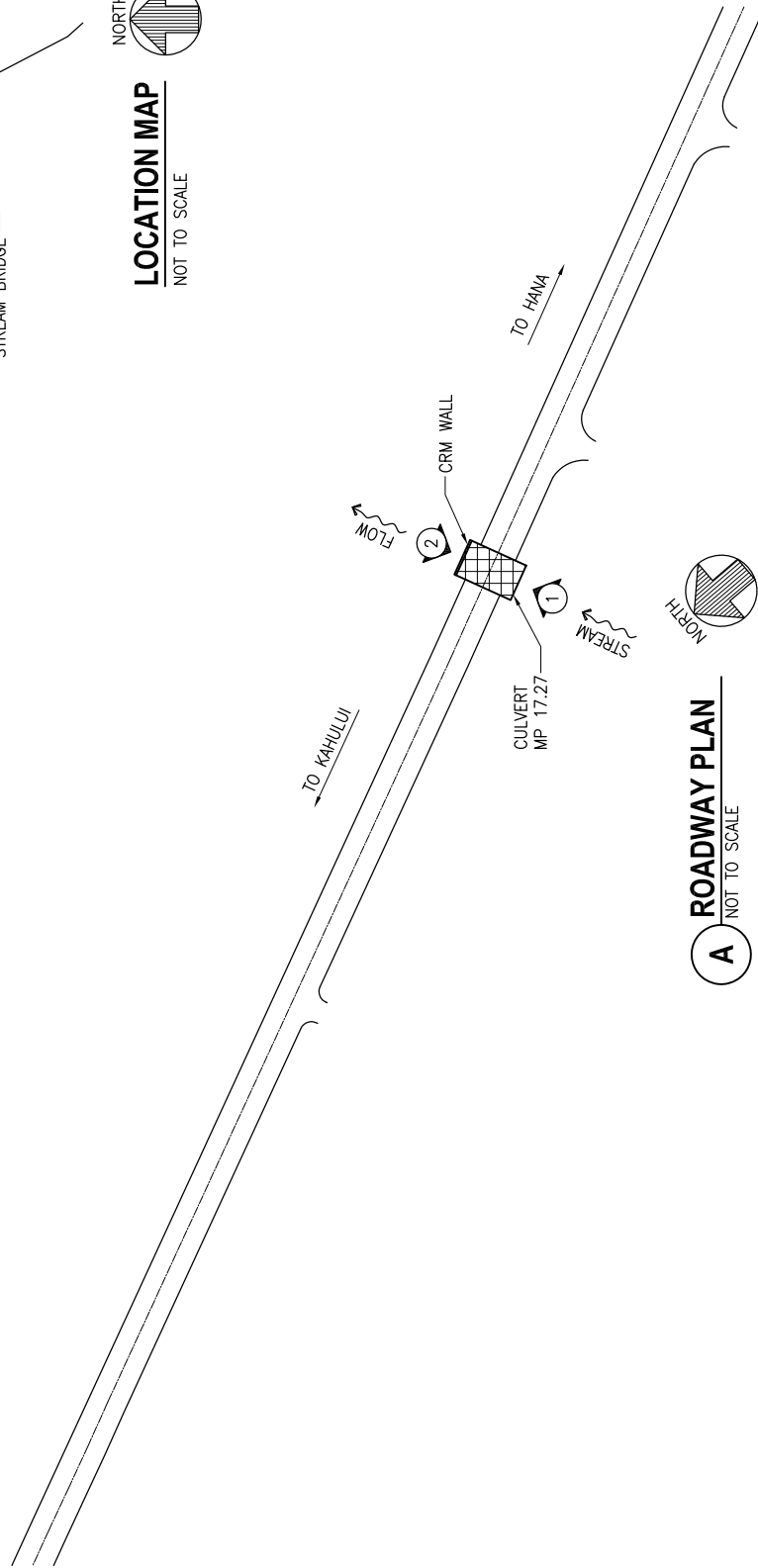


3 - 42" diameter and 1 - 24" diameter RCP inlets at upstream side.



**LOCATION MAP**  
NOT TO SCALE

NORTH

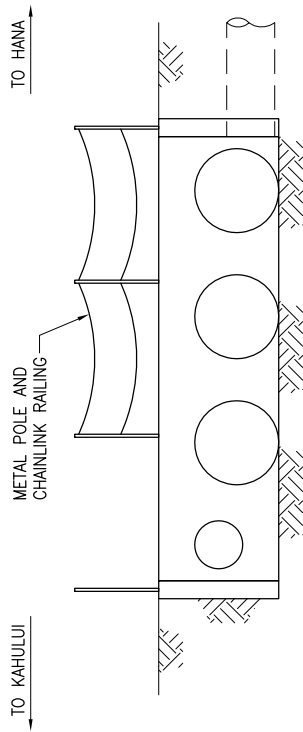


Drawing D: 16C-1

2015

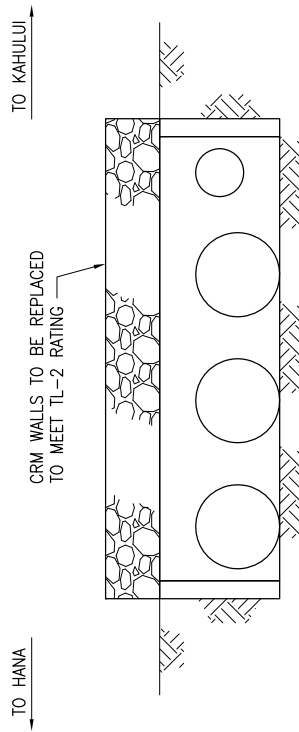
CULVERT MP 17.27





**1** UPSTREAM ELEVATION

NOT TO SCALE



**2** DOWNSTREAM ELEVATION

NOT TO SCALE

17 C	<b>CULVERT MP 17.31</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream metal guardrail.



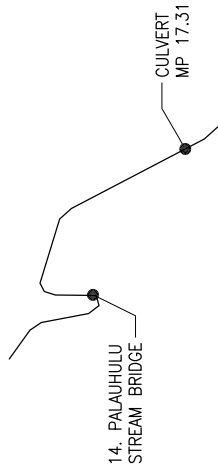
17 C	<b>CULVERT MP 17.31</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



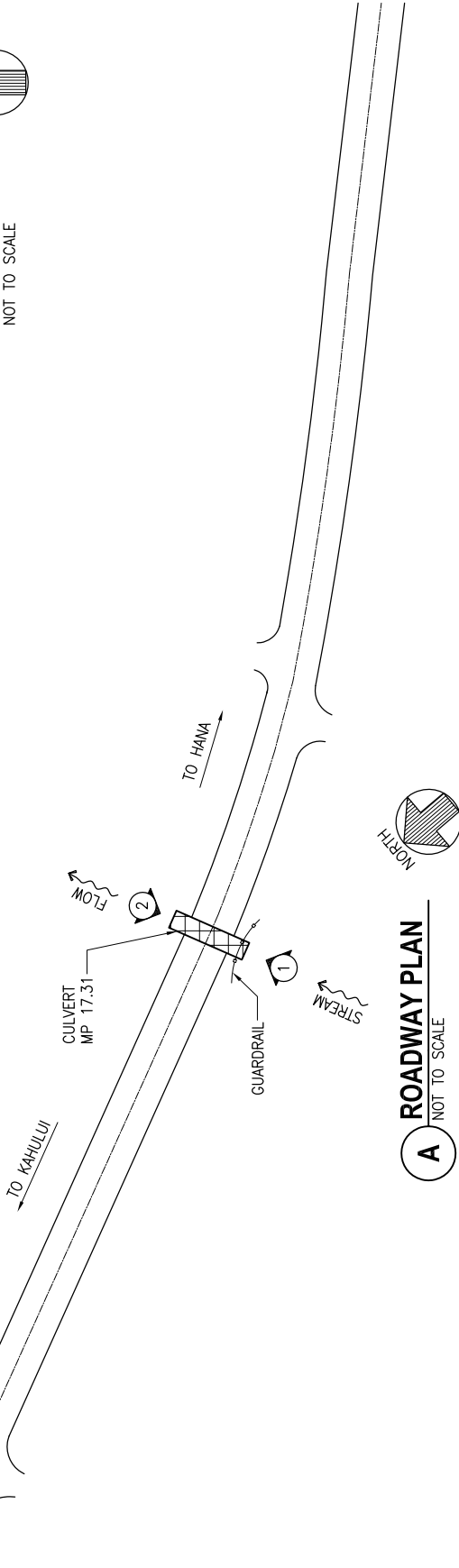
1 - 24" diameter and 1- 36" diameter RCP inlets in upstream CRM headwall.



1 - 36" diameter and 1 - 24" diameter RCP outlets in downstream CRM headwall. 24" outlet is filled with debris.



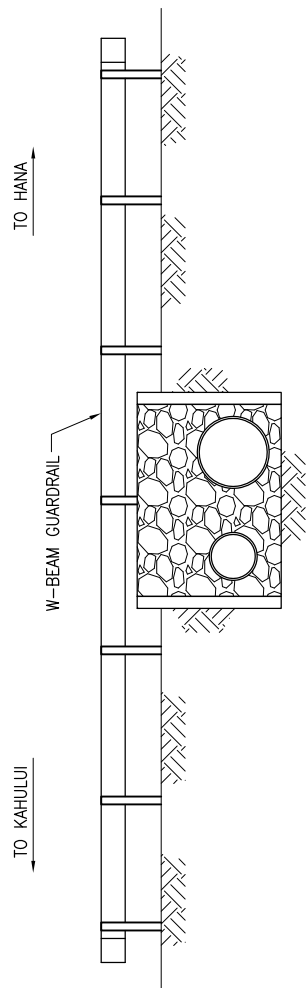
# **LOCATION MAP** NOT TO SCALE



Drawing D: 17C-1

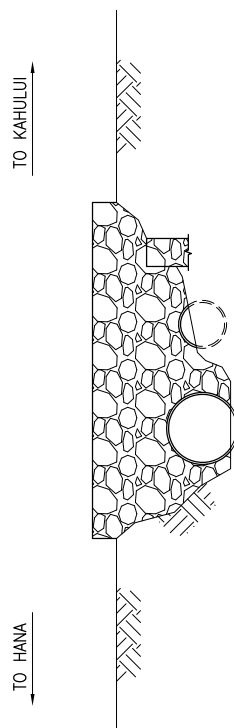
2015

CULVERT MP 17.31



# **UPSTREAM ELEVATION**

1 NOT TO SCALE



# **DOWNSTREAM ELEVATION**

2 NOT TO SCALE



18 C	<b>CULVERT MP 17.36</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



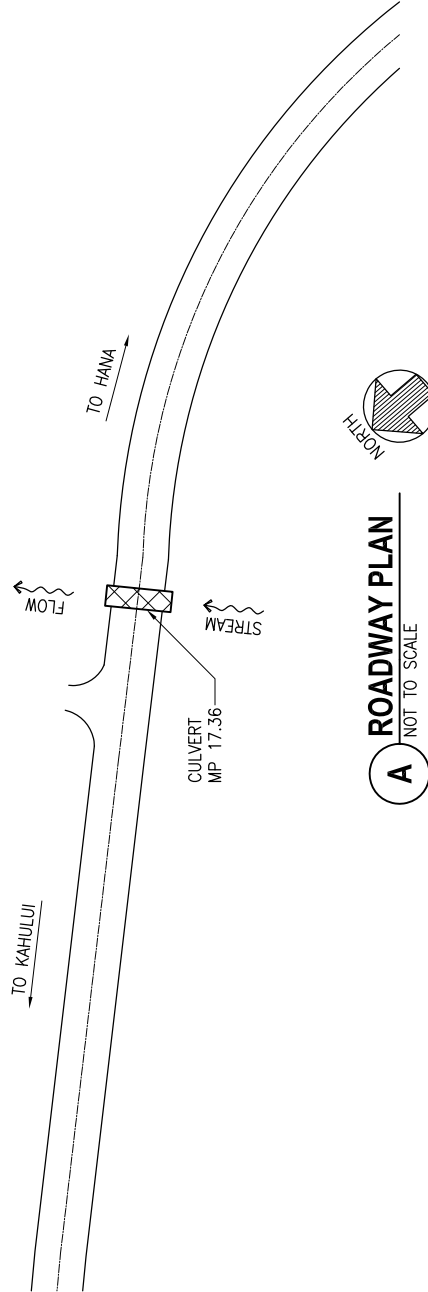
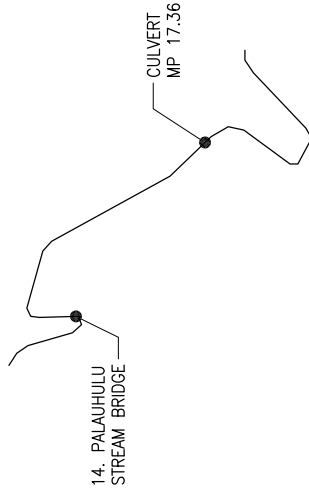
View of downstream fence and top of concrete headwall.



18 C	<b>CULVERT MP 17.36</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



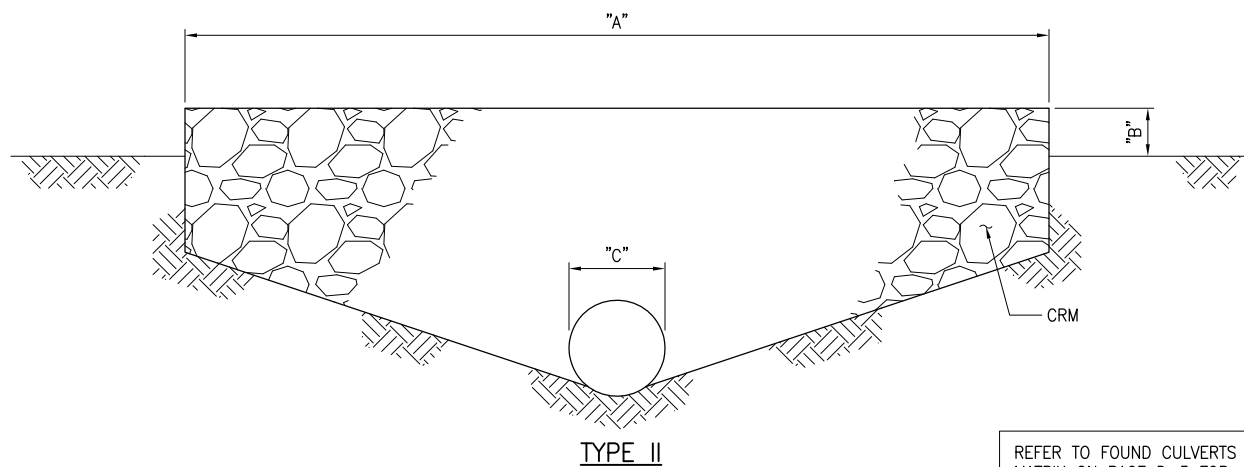
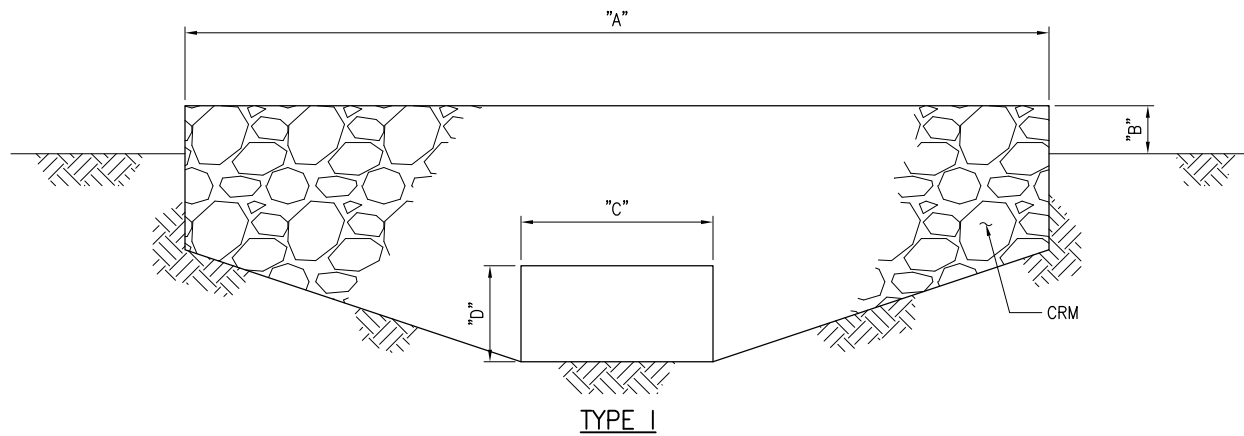
Looking down at RCP outlet at downstream side.



CULVERT MP 17.36

Drawing D: 18C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

22 C	<b>CULVERT MP 17.51 (BRIDGE)</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream metal guardrail.



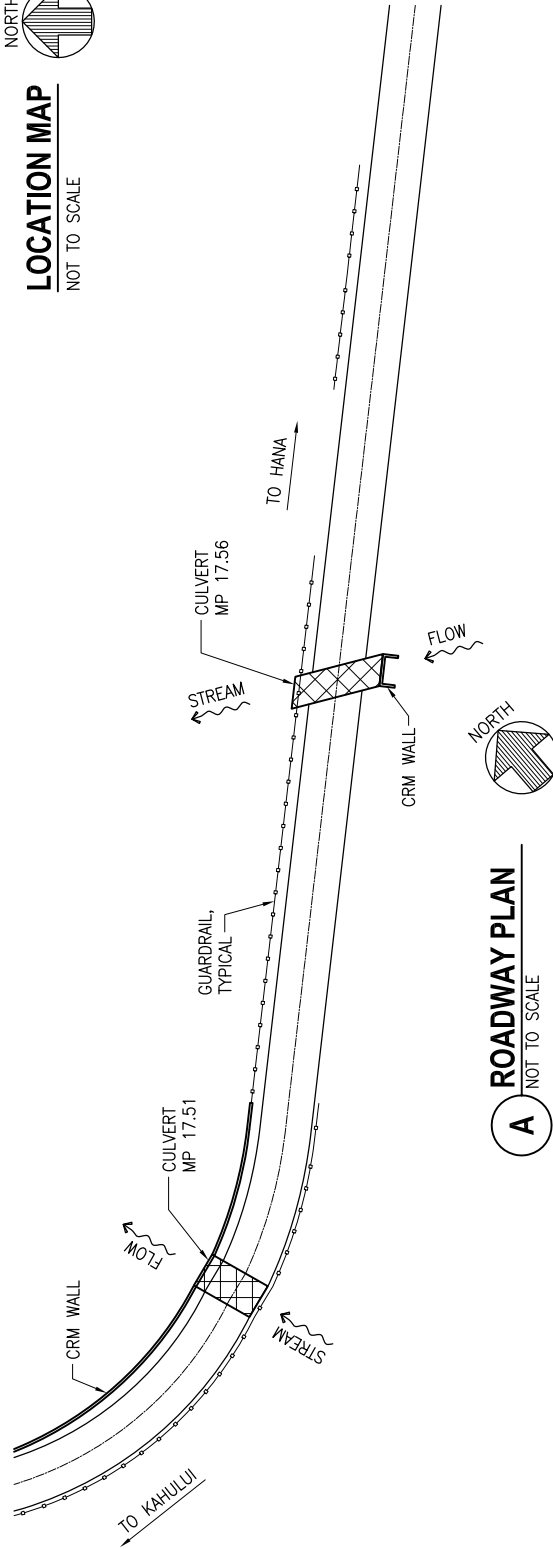
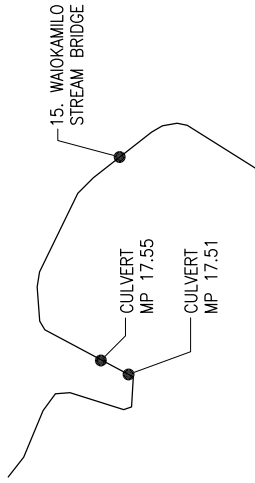
22 C	<b>CULVERT MP 17.51 (BRIDGE)</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of downstream CRM parapet.



Downstream view through upstream end of bridge.

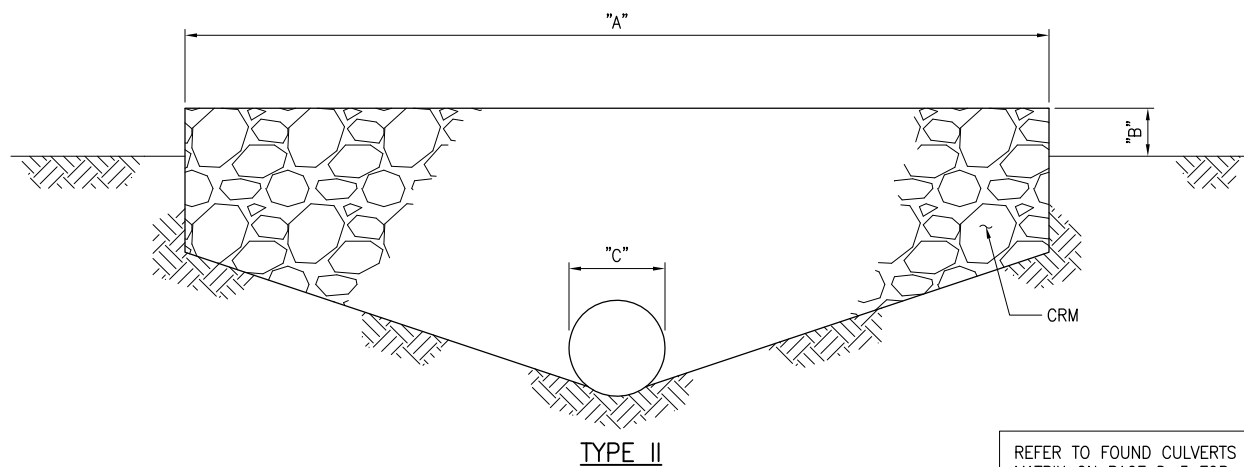
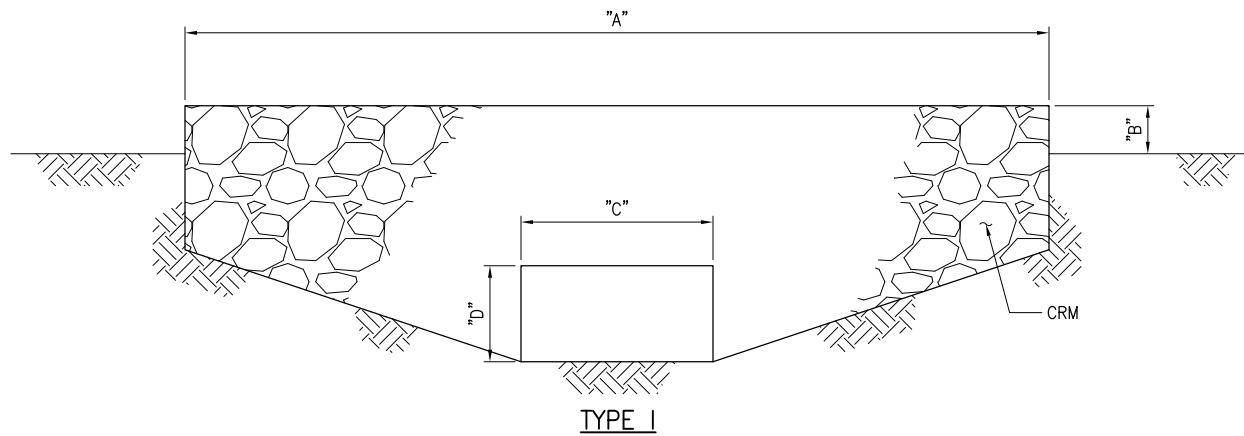


Drawing D: 22C-1 & 23C-1

2015

CULVERT MP 17.51 & CULVERT MP 17.55





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

23 C	<b>CULVERT MP 17.55</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



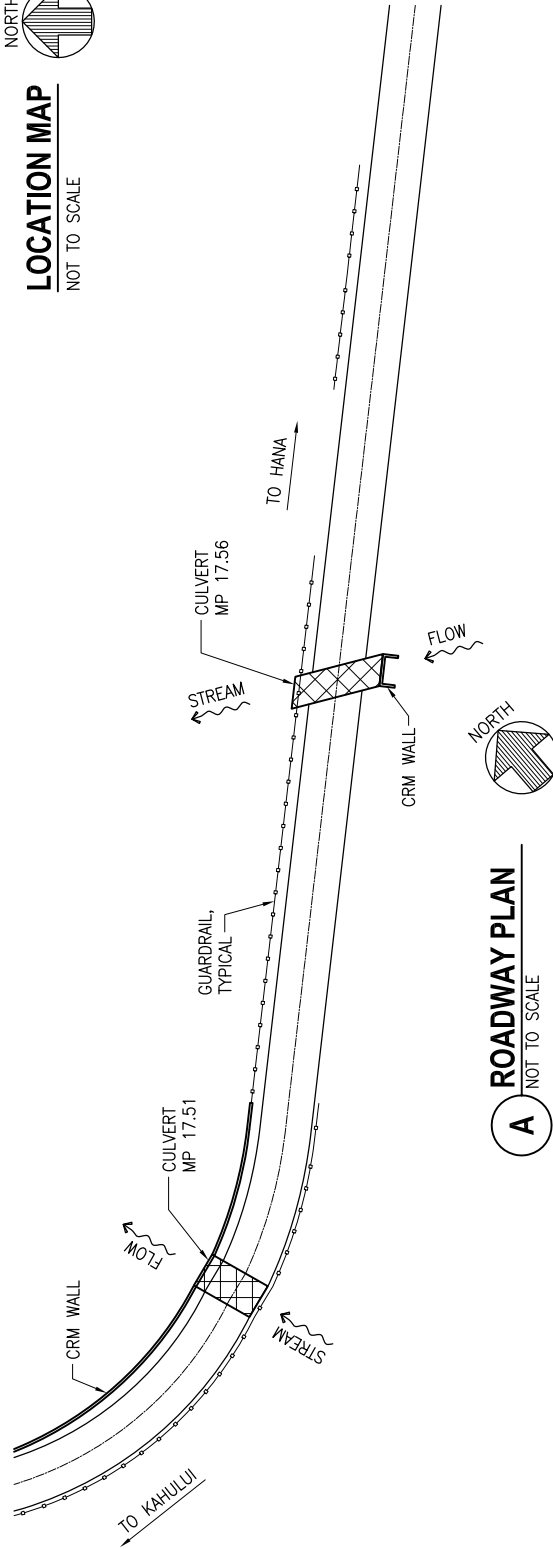
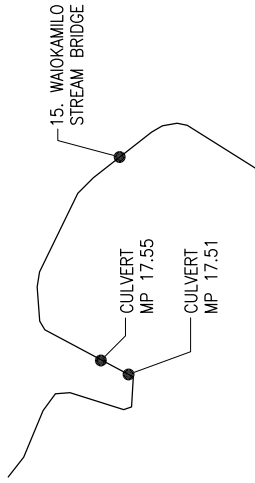
23 C	CULVERT MP 17.55				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream metal guardrail.



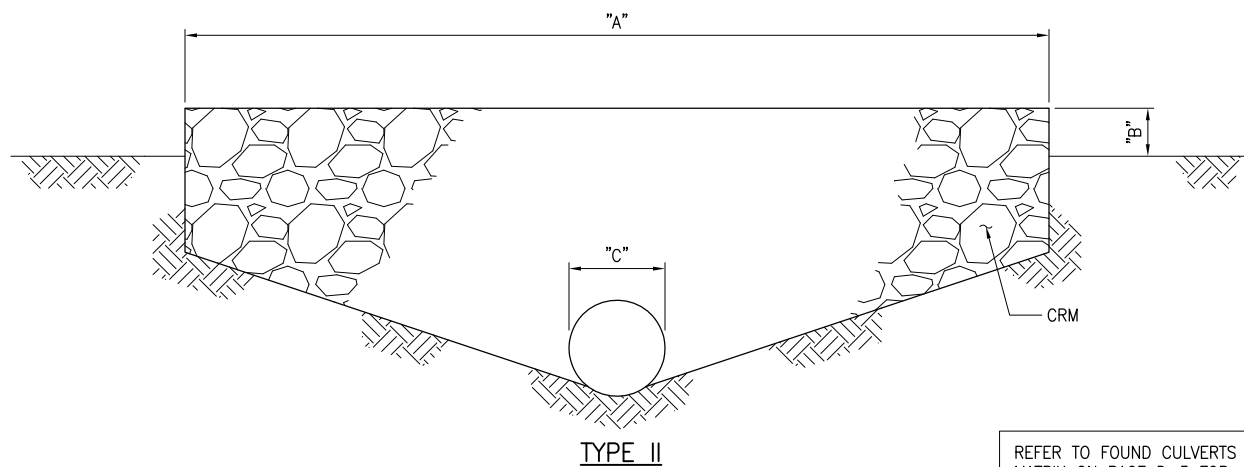
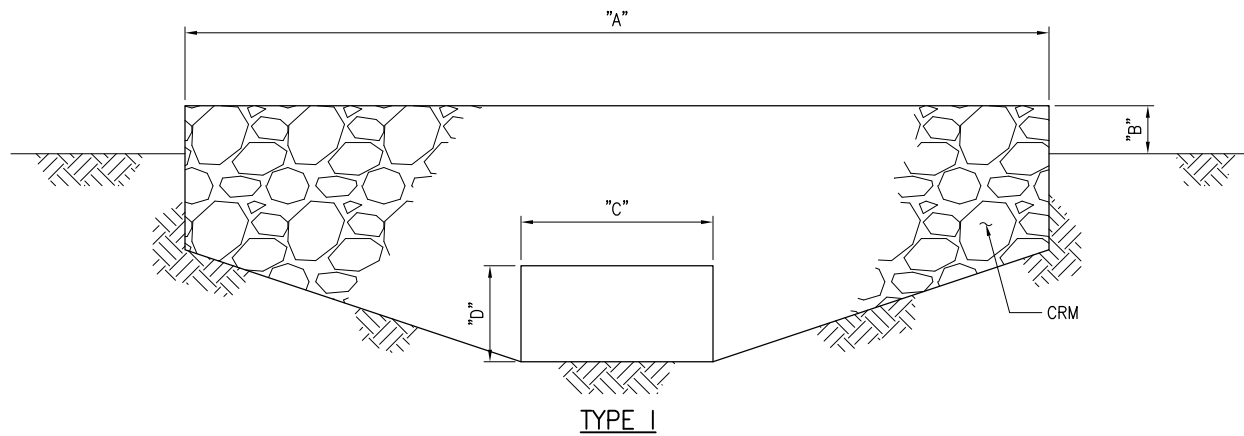
View of upstream CRM headwall / parapet and 24" diameter RCP inlet.



Drawing D: 22C-1 & 23C-1

2015

CULVERT MP 17.51 & CULVERT MP 17.55



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



24 C	CULVERT MP 17.65				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



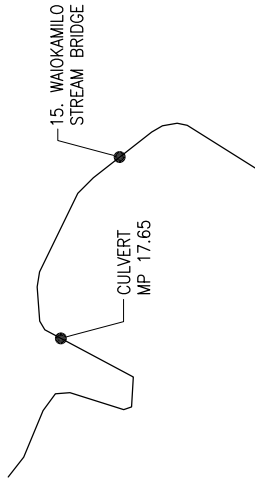
24 C	CULVERT MP 17.65				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



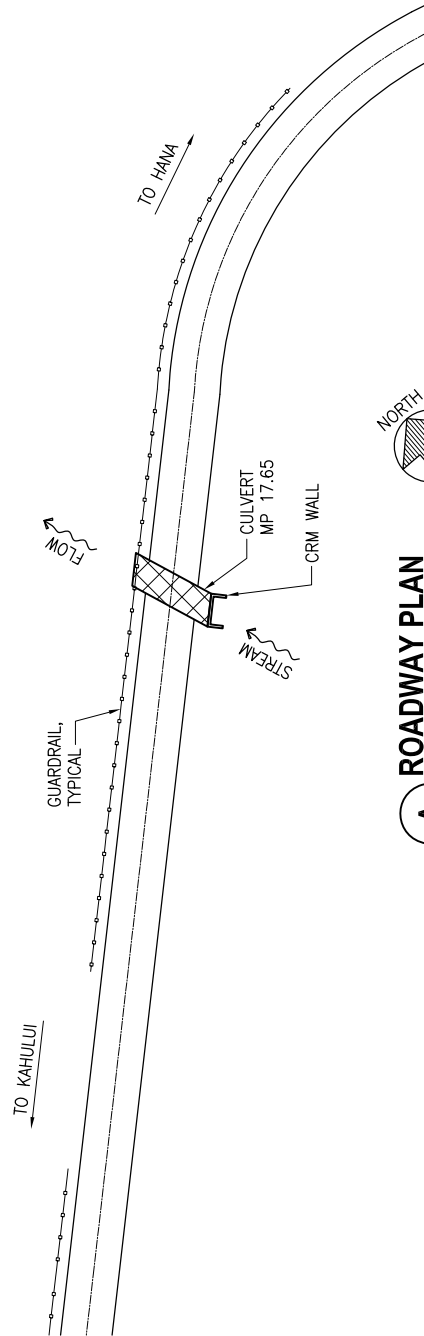
View of downstream metal guardrail.



View of upstream CRM headwall / parapet and 24" diameter RCP inlet.



# **LOCATION MAP** NOT TO SCALE

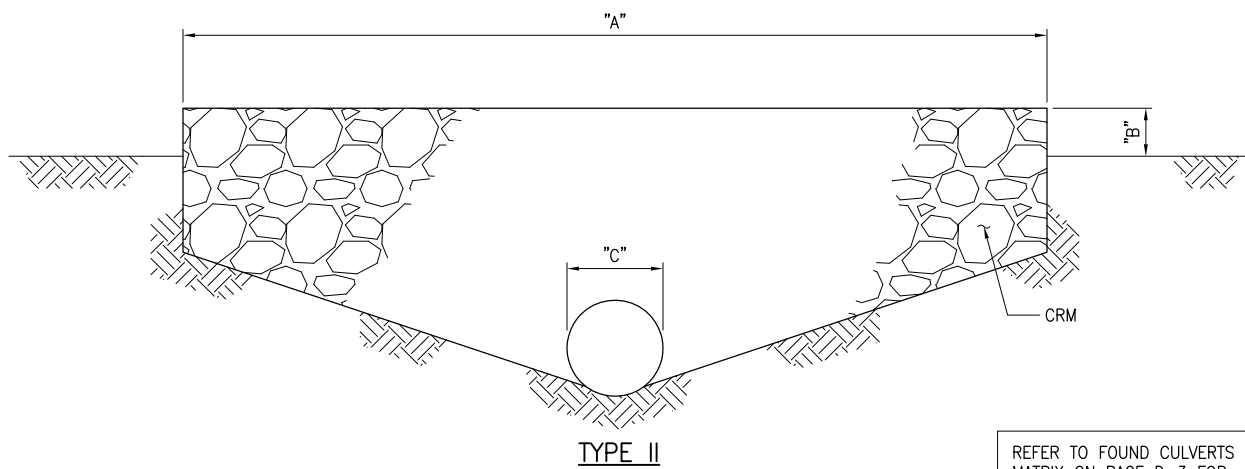
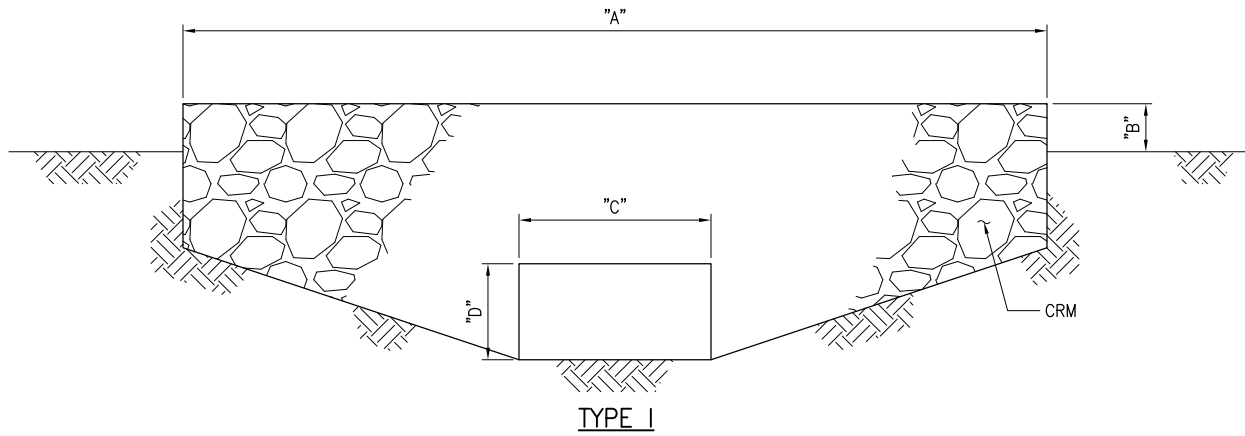


# **A ROADWAY PLAN** NOT TO SCALE

Drawing D: 24C-1

2015

CULVERT MP 17.65



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



26 C	CULVERT MP 20.01				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



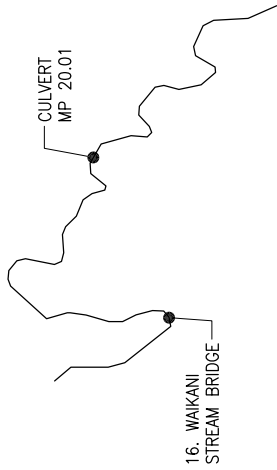
26 C	CULVERT MP 20.01			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of downstream metal guardrail.

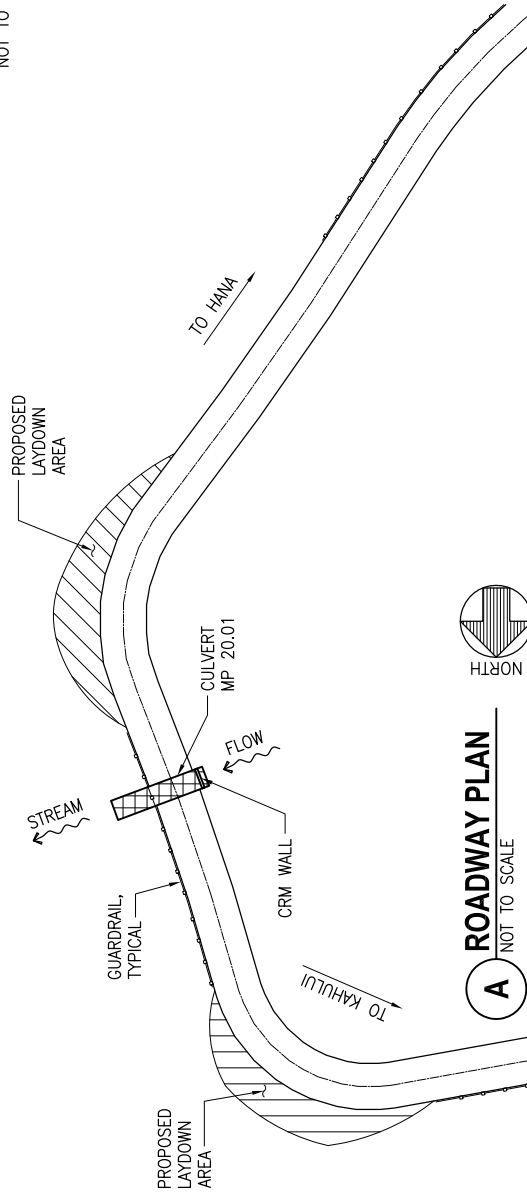


View of upstream CRM headwall / parapet and 30" diameter CMP inlet.



# **LOCATION MAP**

NOT TO SCALE



# **ROADWAY PLAN**

NOT TO SCALE

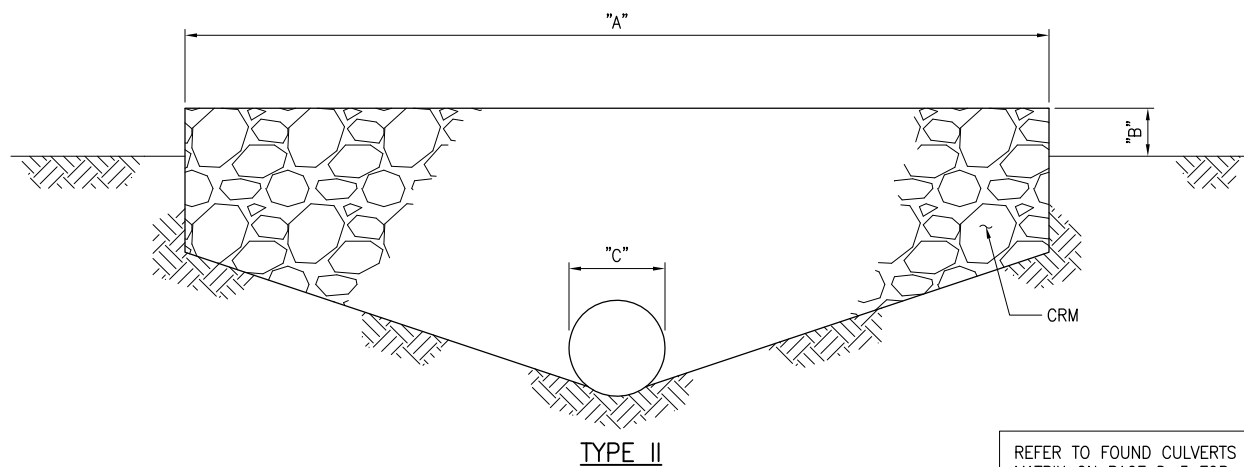
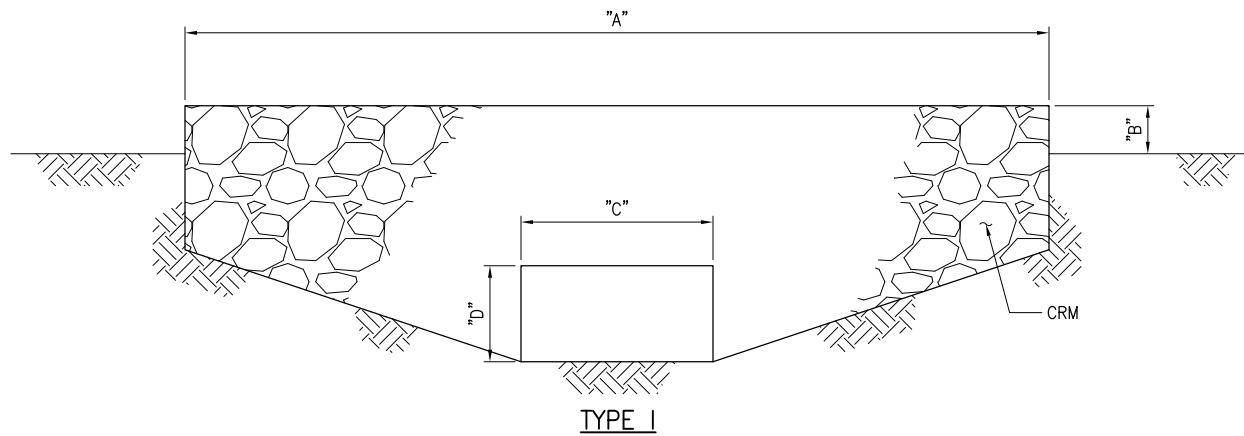
**A**

Drawing D: 26C-1

2015

CULVERT MP 20.01





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

27 C	<b>CULVERT MP 20.03</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



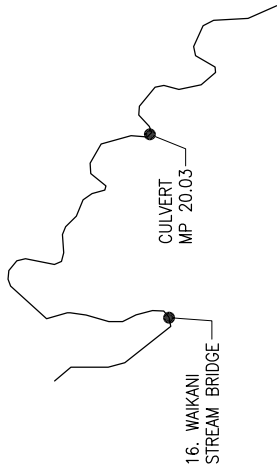
27 C	<b>CULVERT MP 20.03</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



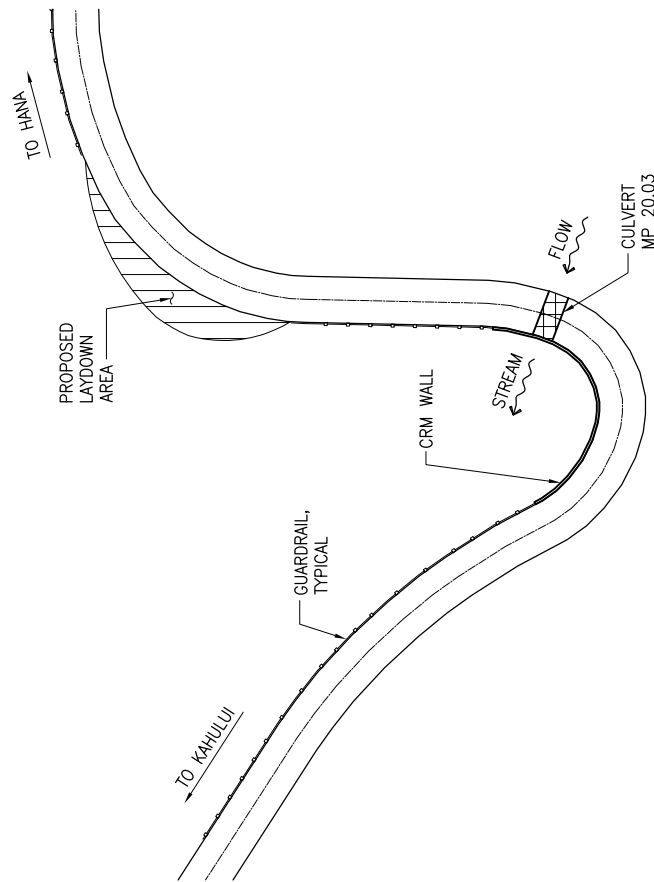
View of downstream CRM parapet.



36" diameter CMP inlet at upstream side.



# **LOCATION MAP** NOT TO SCALE

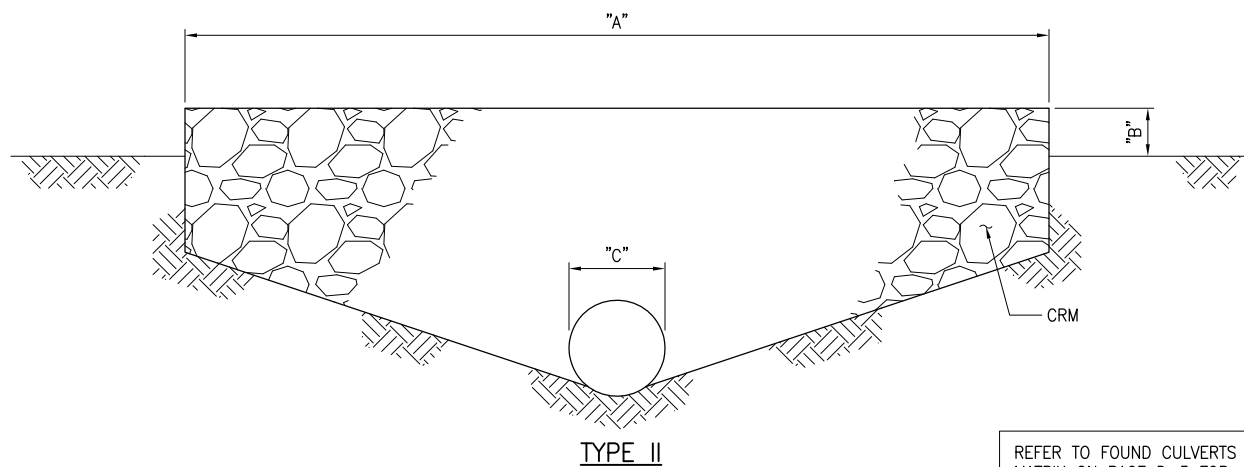
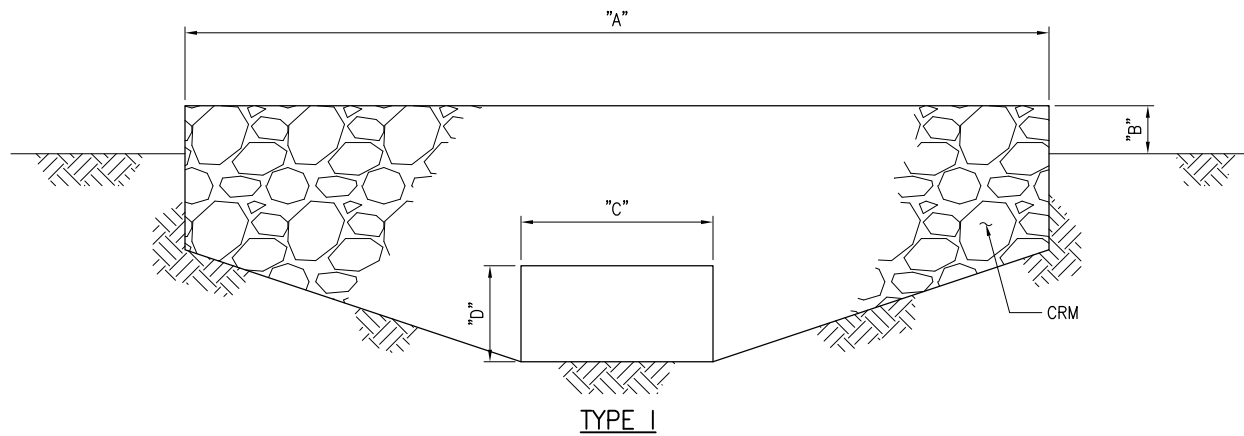


# **A ROADWAY PLAN** NOT TO SCALE

Drawing D: 27C-1

2015

CULVERT MP 20.03



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



28 C	CULVERT MP 20.05				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana and upstream CRM parapet.



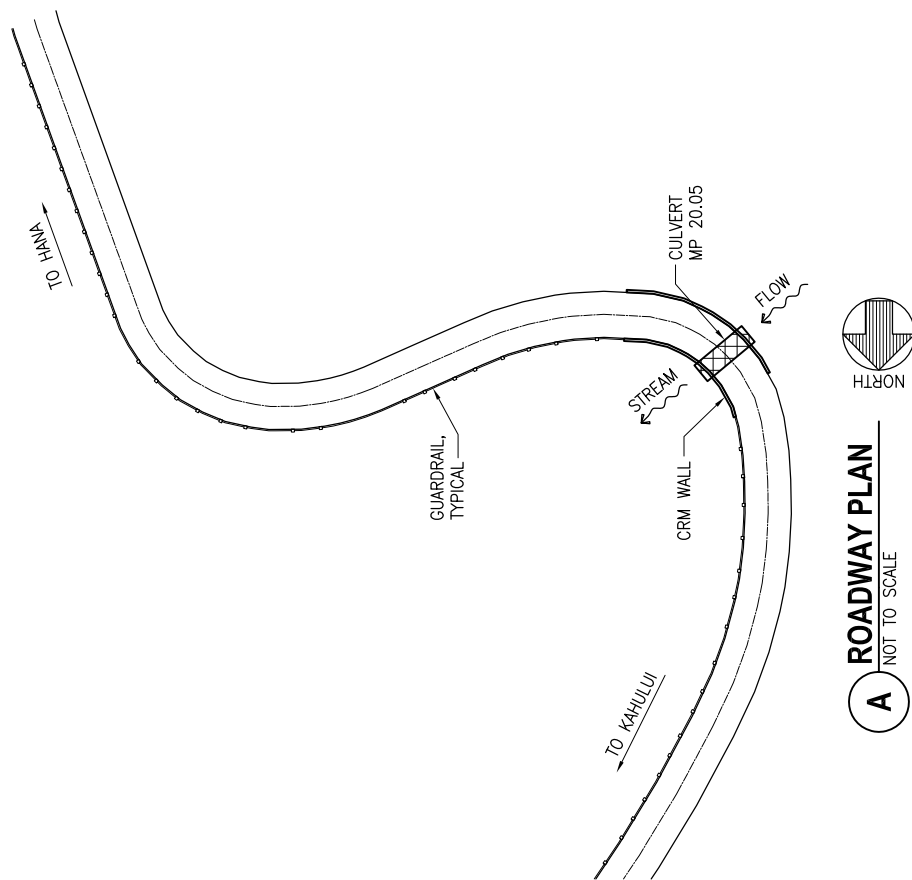
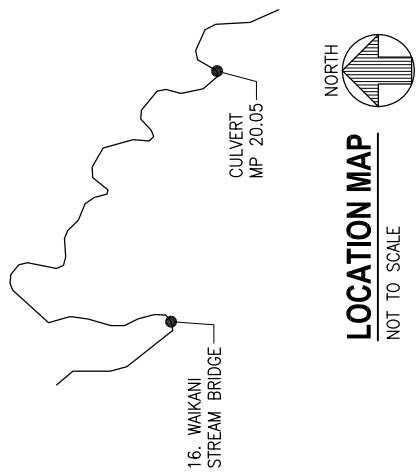
View of downstream CRM parapet.



28 C	<b>CULVERT MP 20.05</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



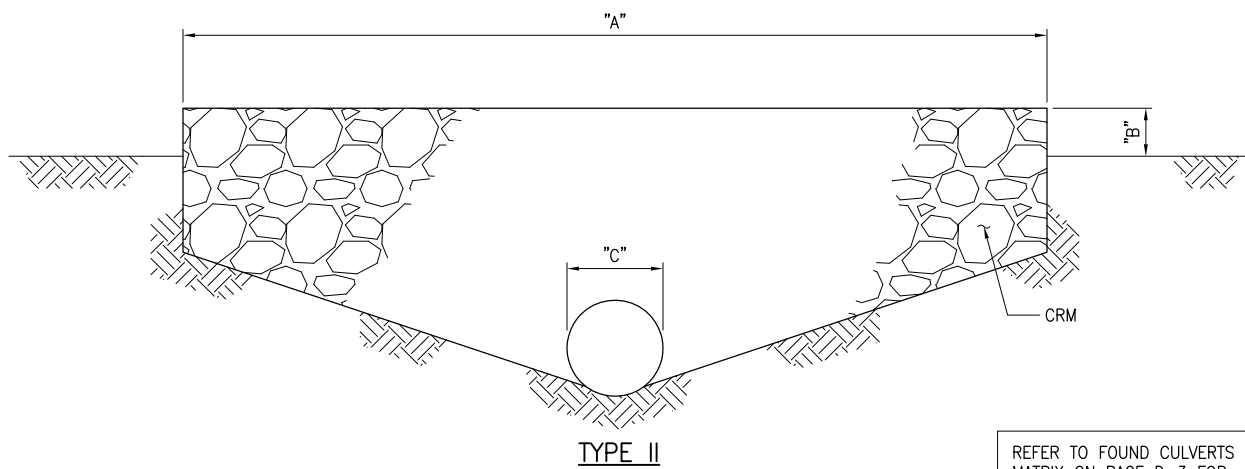
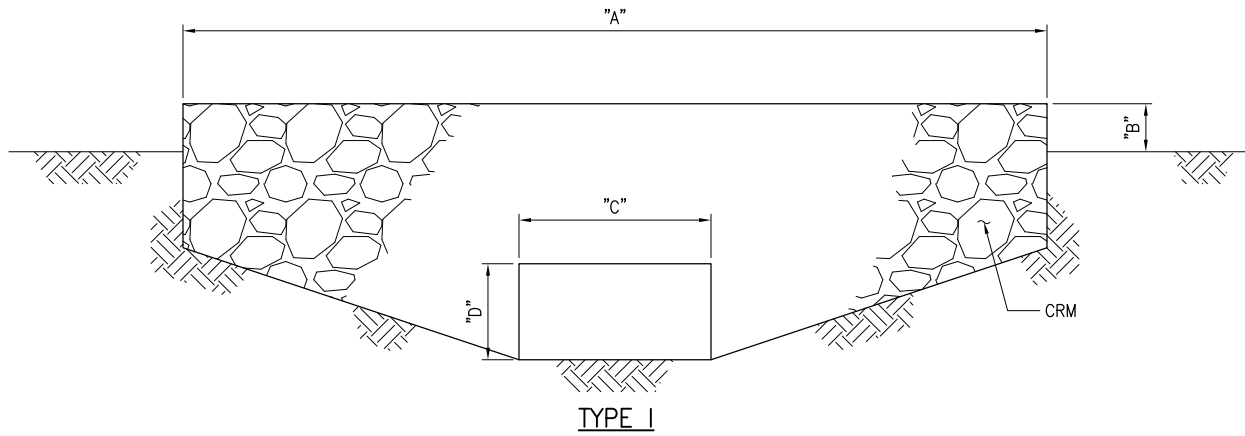
48" diameter CMP inlet at upstream side.



Drawing D: 28C-1

2015

CULVERT MP 20.05



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

29 C	<b>CULVERT MP 21.00</b>				
	<b>Bridge Number:</b>	N/A		<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown		<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement				



Kahului approach looking toward Hana.



View of upstream CRM parapet.



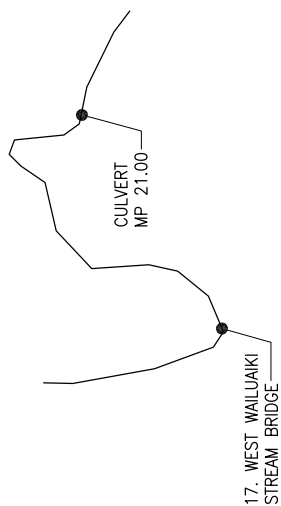
29 C	<b>CULVERT MP 21.00</b>				
	<b>Bridge Number:</b>	N/A		<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown		<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement				



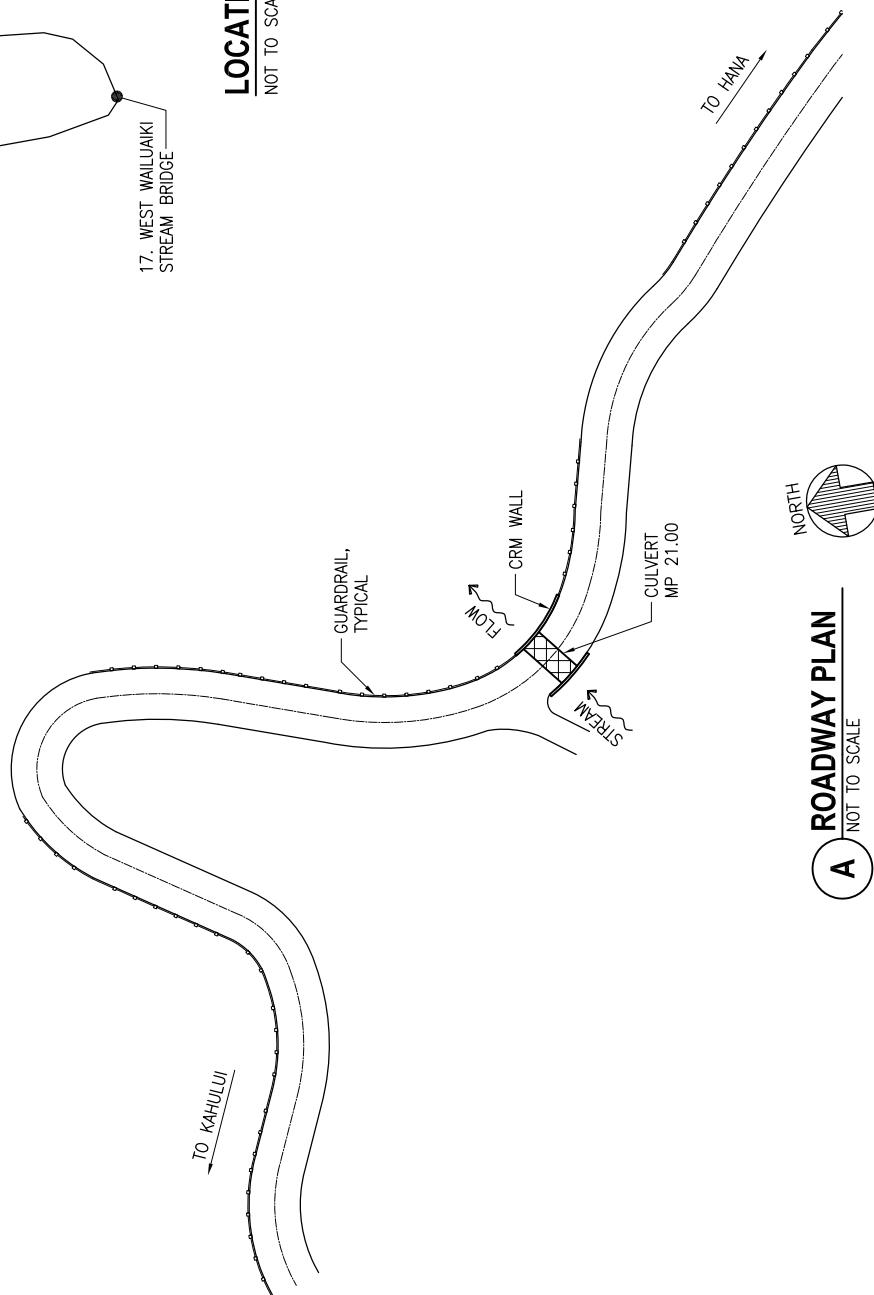
View of downstream CRM parapet.



View of downstream through culvert.



# **LOCATION MAP** NOT TO SCALE



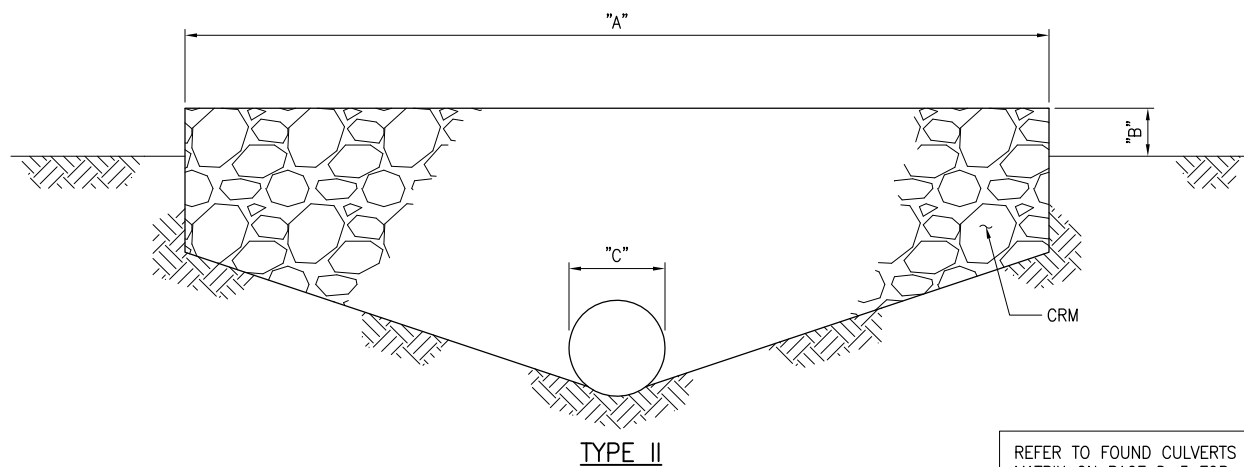
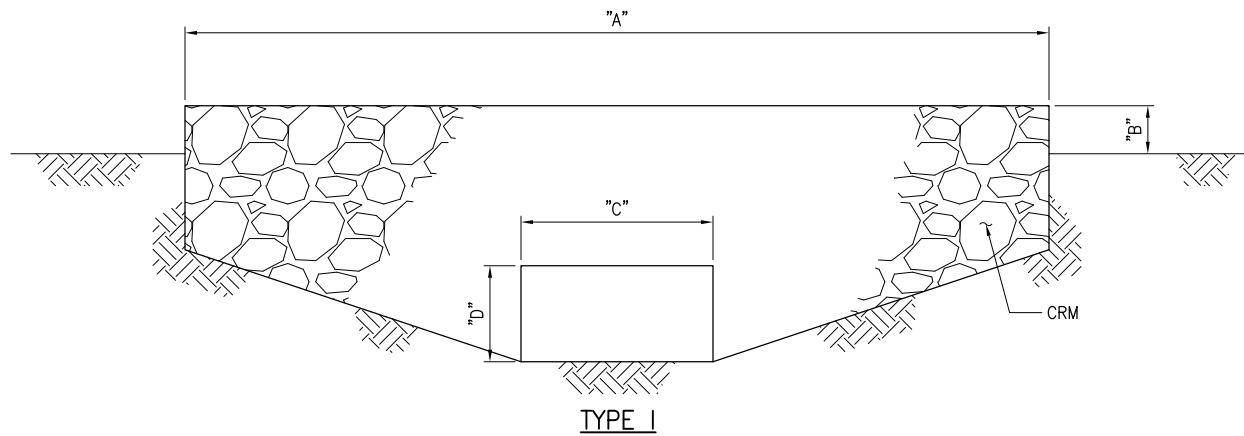
# **ROADWAY PLAN** A NOT TO SCALE

Drawing D: 29C-1

2015

CULVERT MP 21.00





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

30 C	<b>CULVERT MP 21.11</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



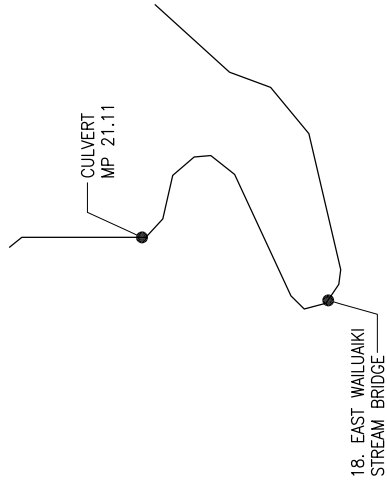
30 C	CULVERT MP 21.11				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream CRM parapet.

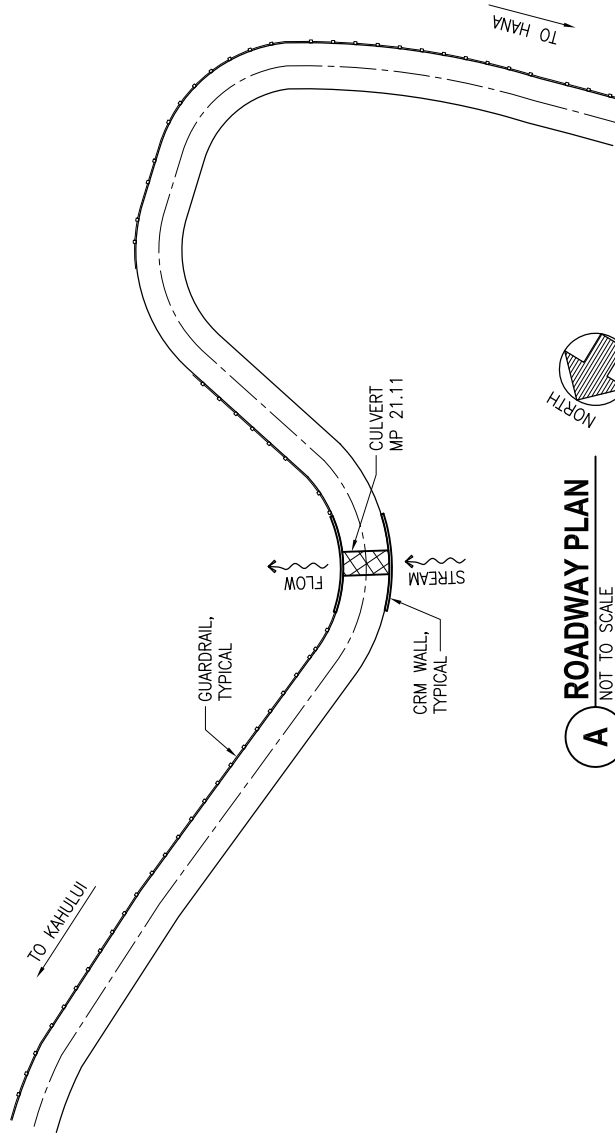


View of downstream through culvert.



# LOCATION MAP

NOT TO SCALE



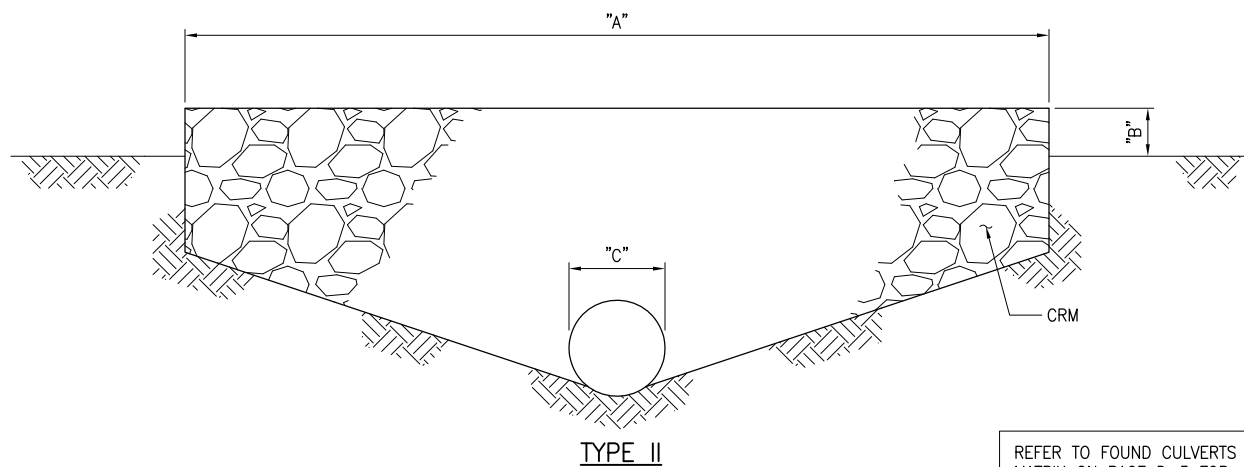
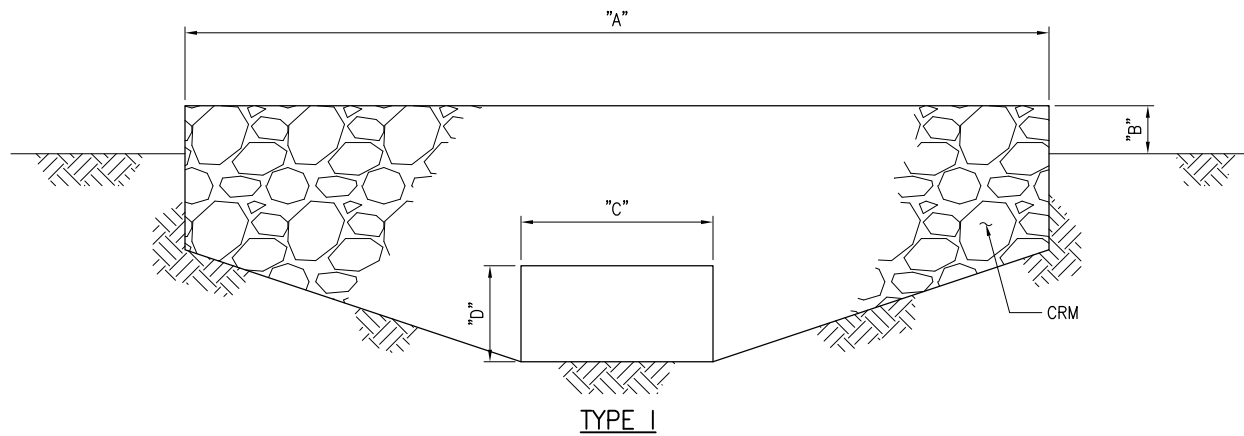
# ROADWAY PLAN

A NOT TO SCALE

Drawing D: 30C-1

2015

CULVERT MP 21.11



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



31 C	<b>CULVERT MP 21.29</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



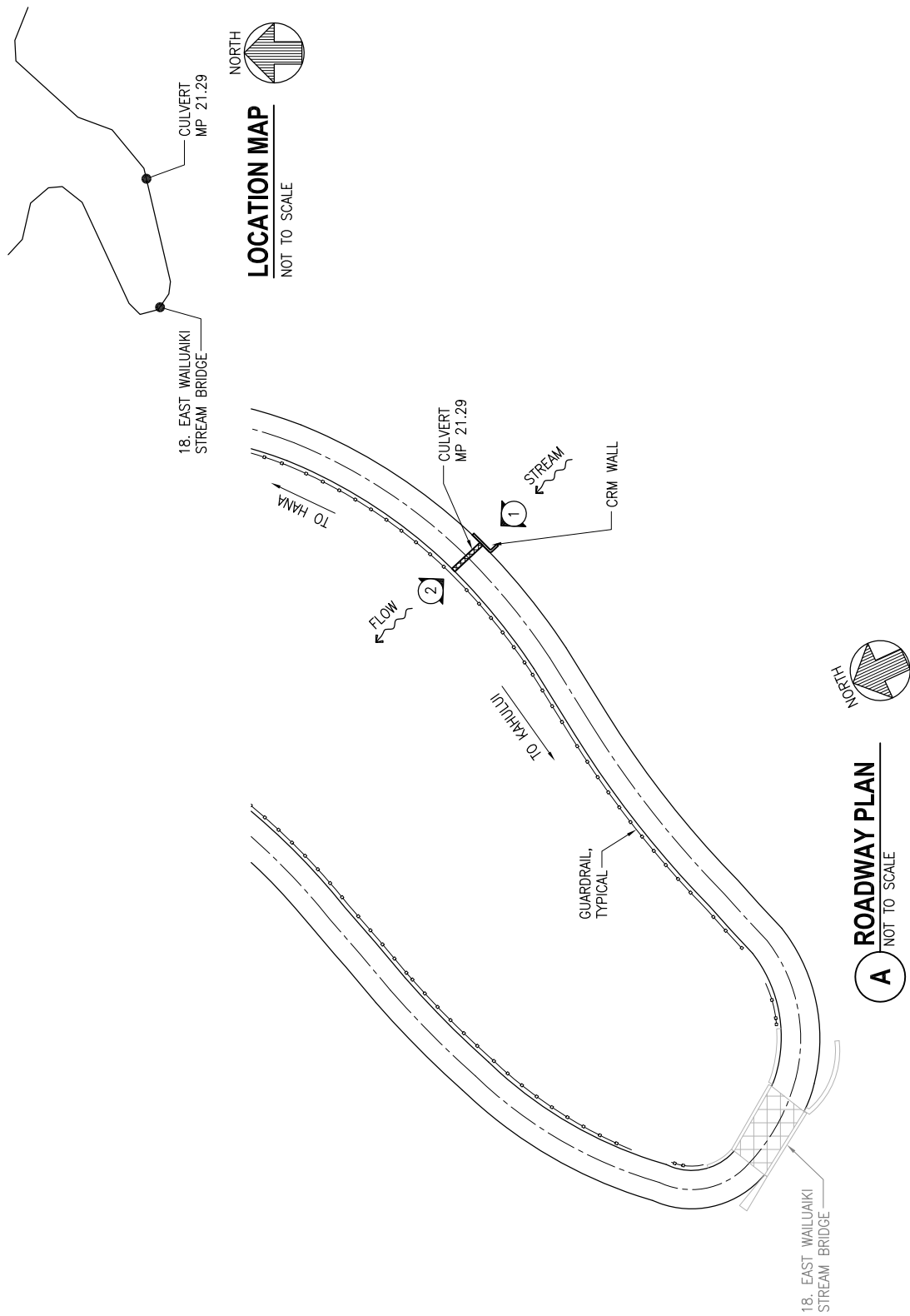
31 C	<b>CULVERT MP 21.29</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of downstream metal guardrail.



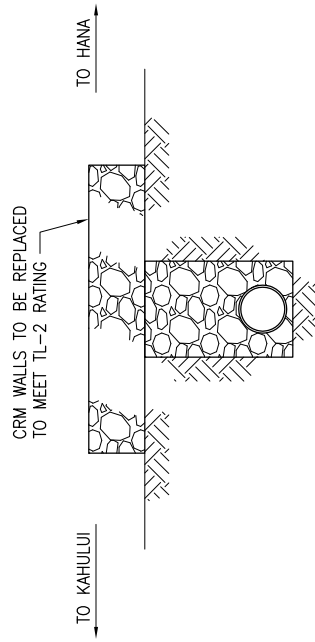
24" diameter RCP inlet at the upstream side.



Drawing D: 31C-1

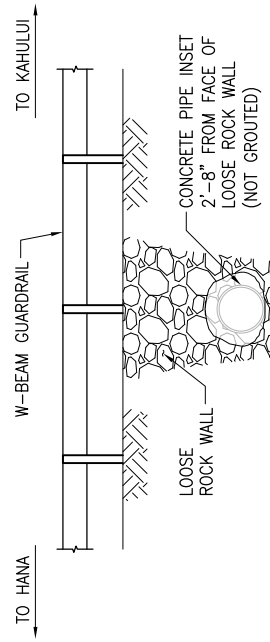
2015

CULVERT MP 21.29



# 1 UPSTREAM ELEVATION

NOT TO SCALE



# 2 DOWNSTREAM ELEVATION

NOT TO SCALE



32 C	<b>CULVERT MP 21.92</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream concrete parapet.



32 C	<b>CULVERT MP 21.92</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement

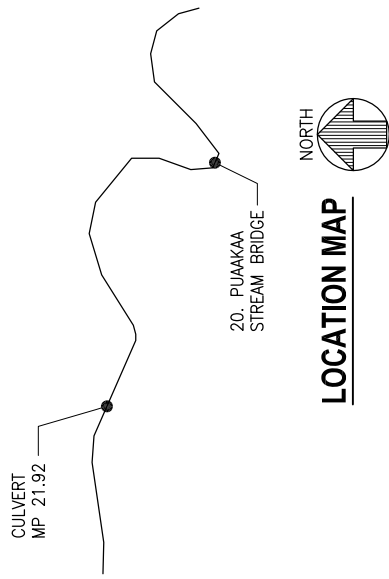


View of downstream metal guardrail.

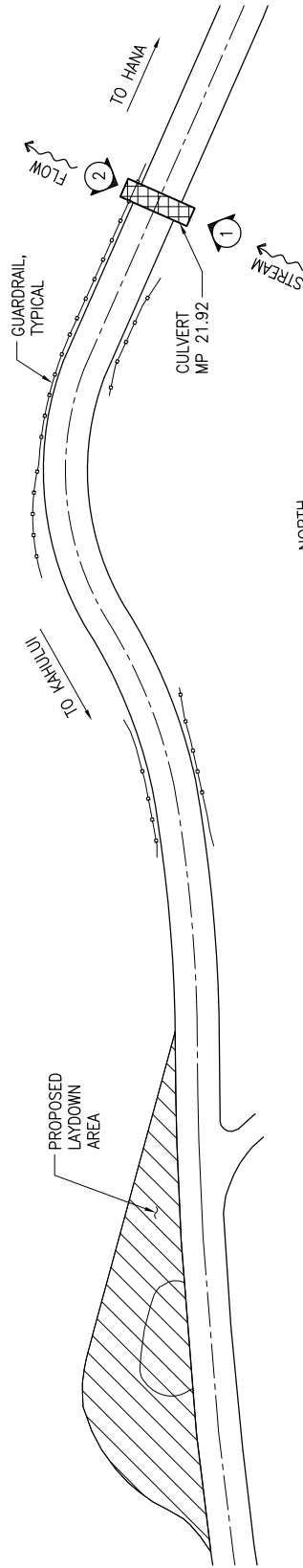


2 - 24" diameter RCP inlets at upstream side.





## LOCATION MAP

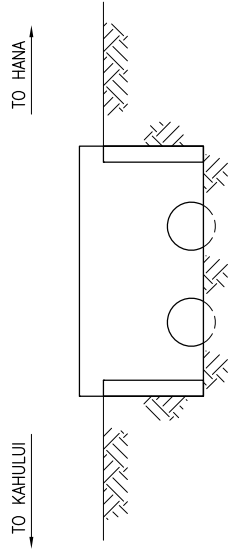


## A ROADWAY PLAN NOT TO SCALE

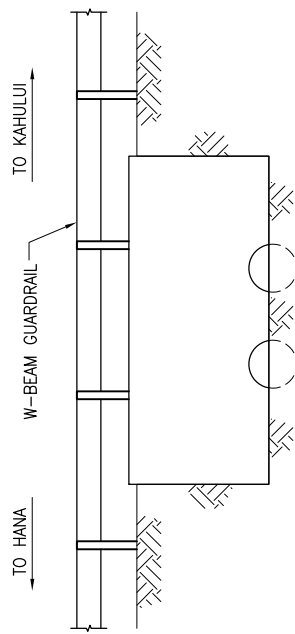
Drawing D: 32C-1

2015

CULVERT MP 21.92



**1** UPSTREAM ELEVATION  
NOT TO SCALE



**2** DOWNSTREAM ELEVATION  
NOT TO SCALE

33 C	CULVERT MP 22.10				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



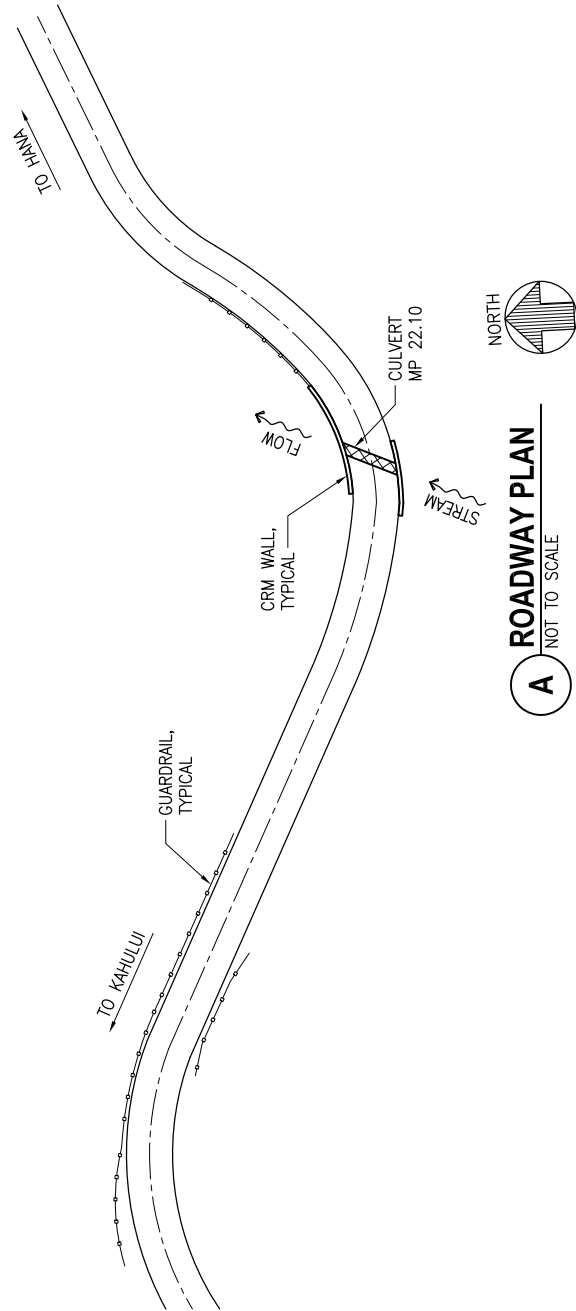
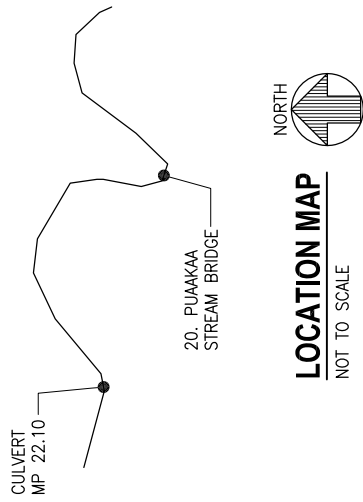
33 C	<b>CULVERT MP 22.10</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream CRM parapet.



View of CRM parapet and concrete headwall at upstream side.

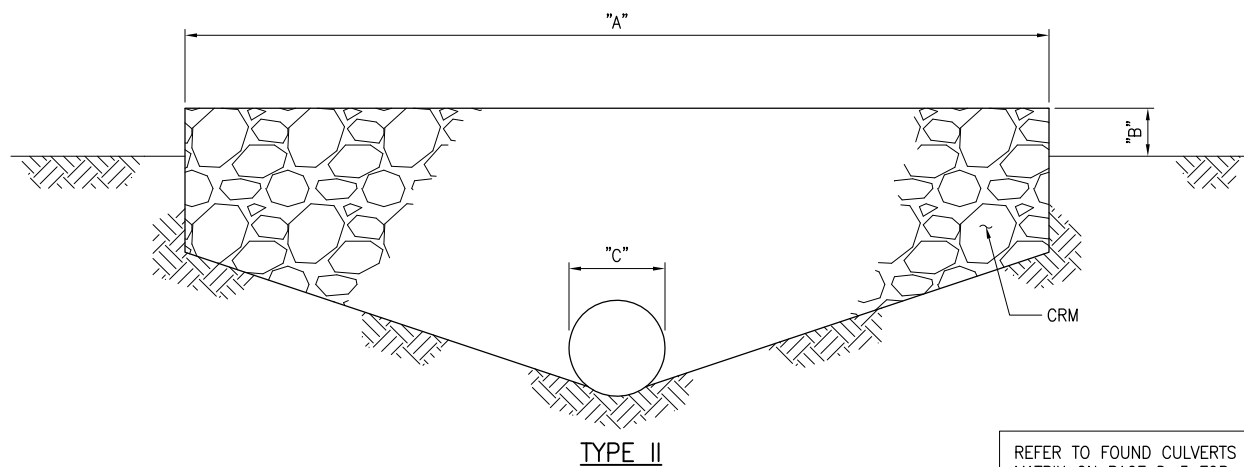
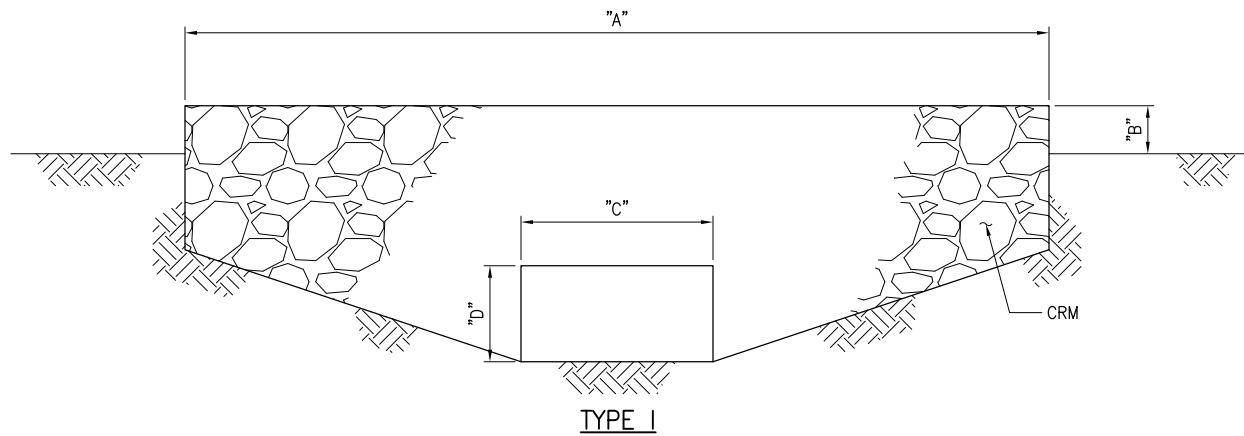


CULVERT MP 22.10

Drawing D: 33C-1

2015





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

34 C	CULVERT MP 22.52			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



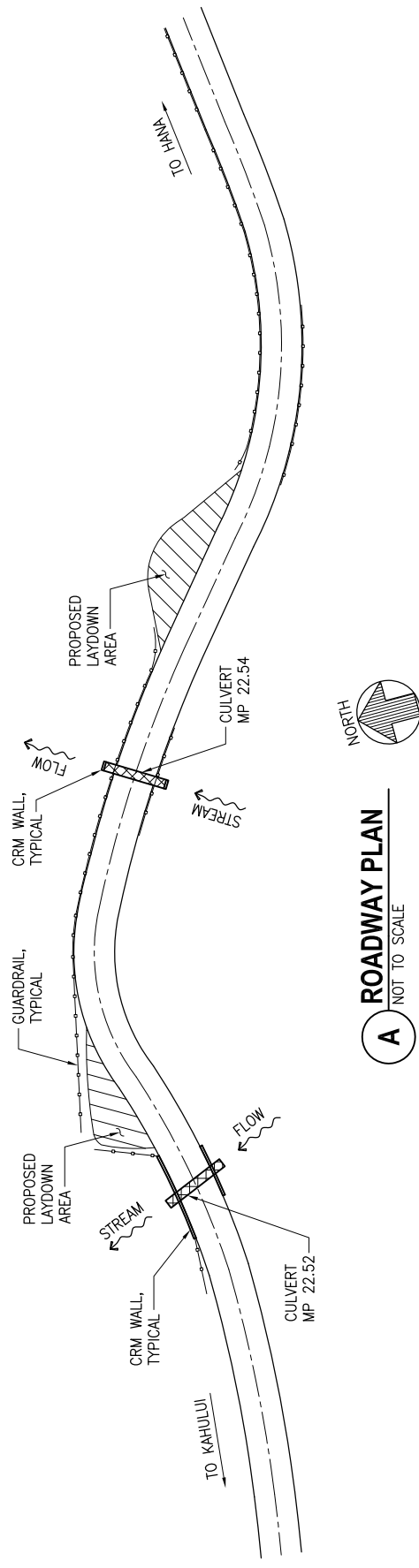
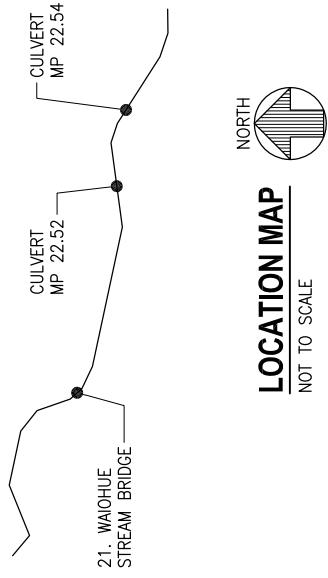
34 C	CULVERT MP 22.52				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream CRM parapet.



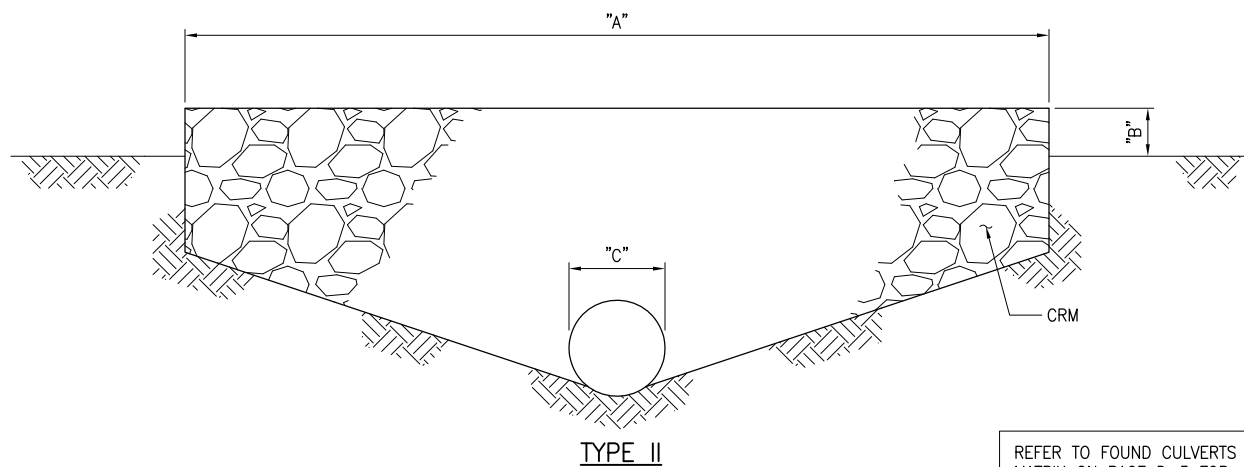
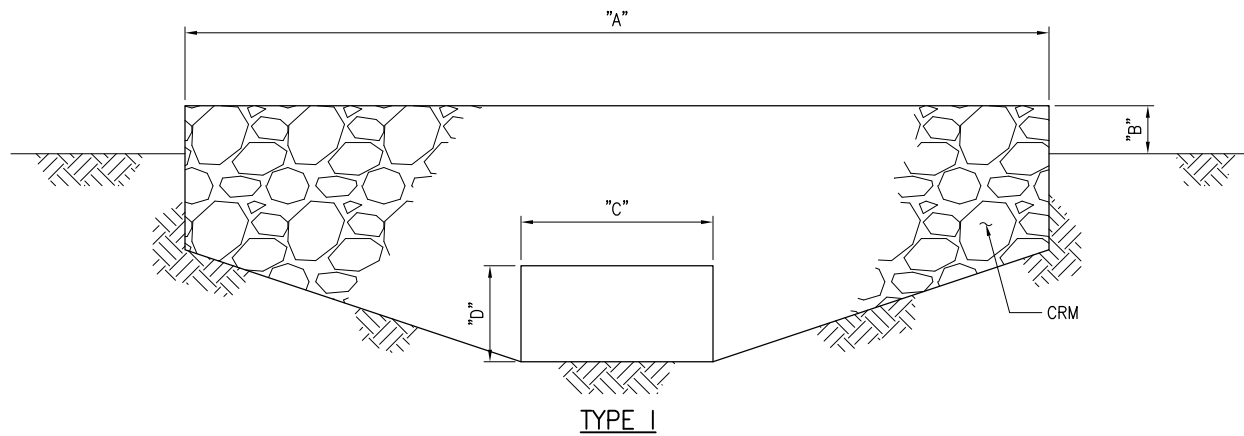
View of upstream CRM headwall / parapet.



Drawing D: 34C-1 & 35C-1

2015

CULVERT MP 22.52 & CULVERT MP 22.54



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



# 35 CULVERT MP 22.54

C

Bridge Number:	N/A		Island:	Maui	
Date of Construction:	Unknown		Route:	Hana Highway	
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement	



Kahului approach looking toward Hana.



View of upstream CRM parapet with continuous metal guardrail in-front.



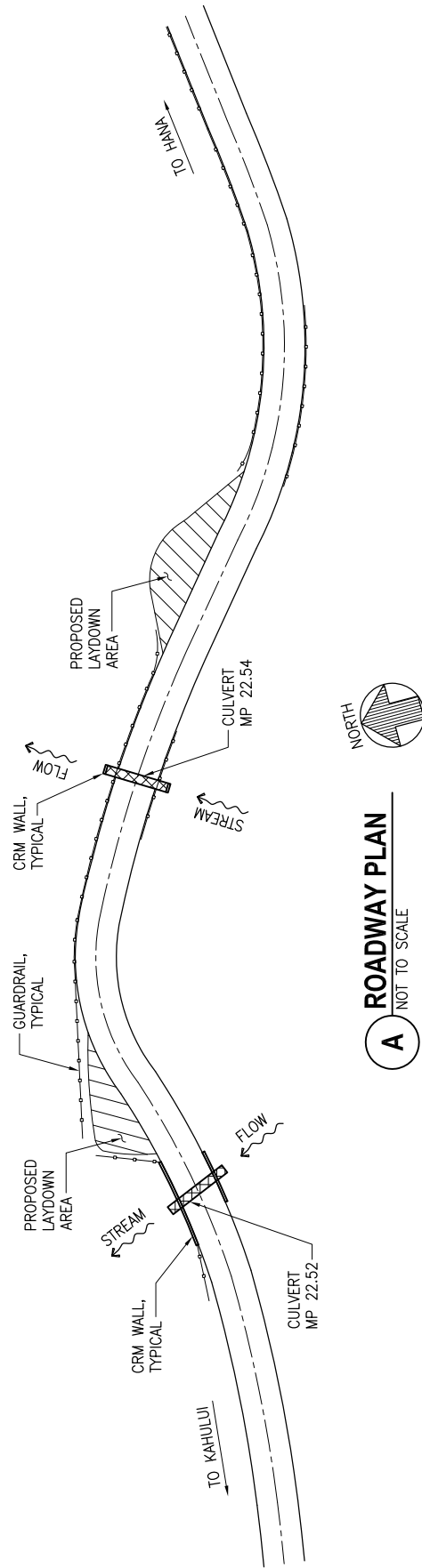
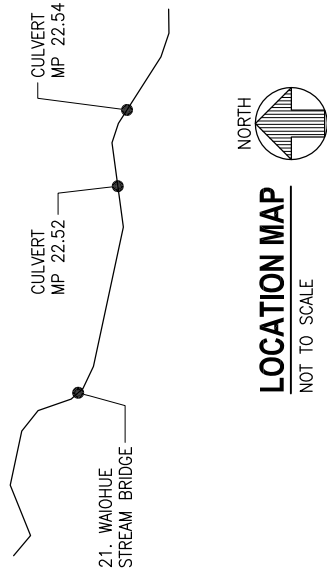
35 C	<b>CULVERT MP 22.54</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream CRM parapet with continuous metal guardrail in-front.



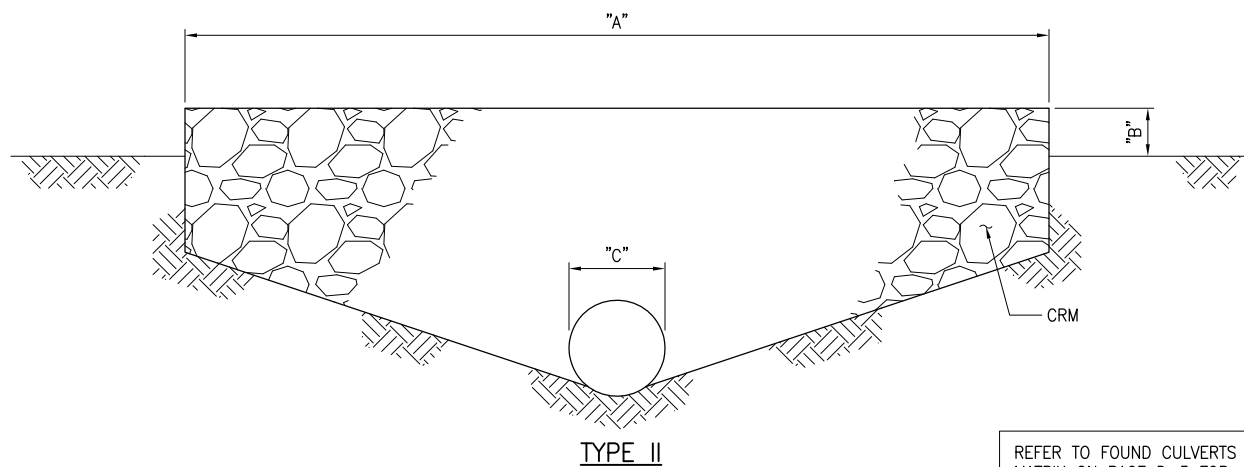
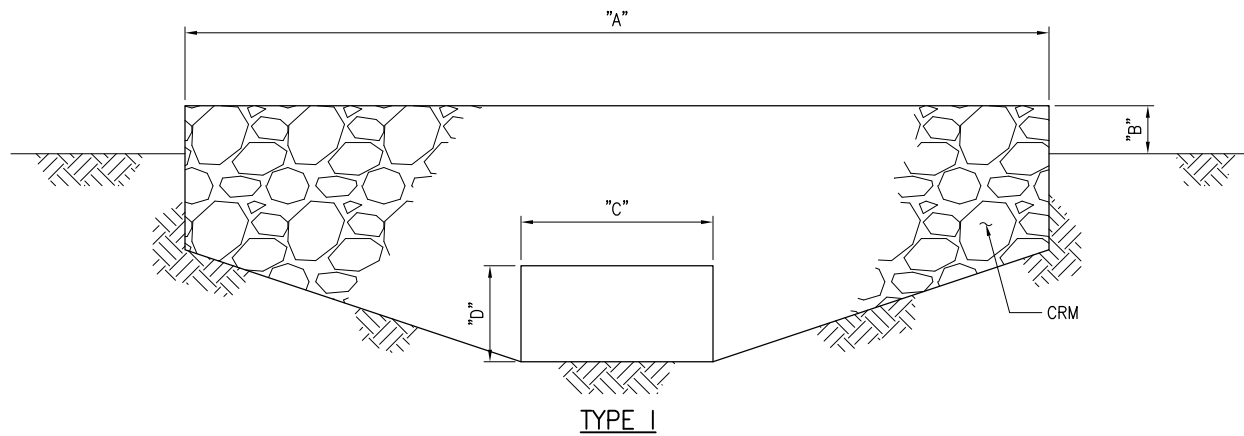
18" diameter RCP inlet at the upstream side.



CULVERT MP 22.52 & CULVERT MP 22.54

Drawing D: 34C-1 & 35C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



36 C	<b>CULVERT MP 22.79</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream metal guardrail.



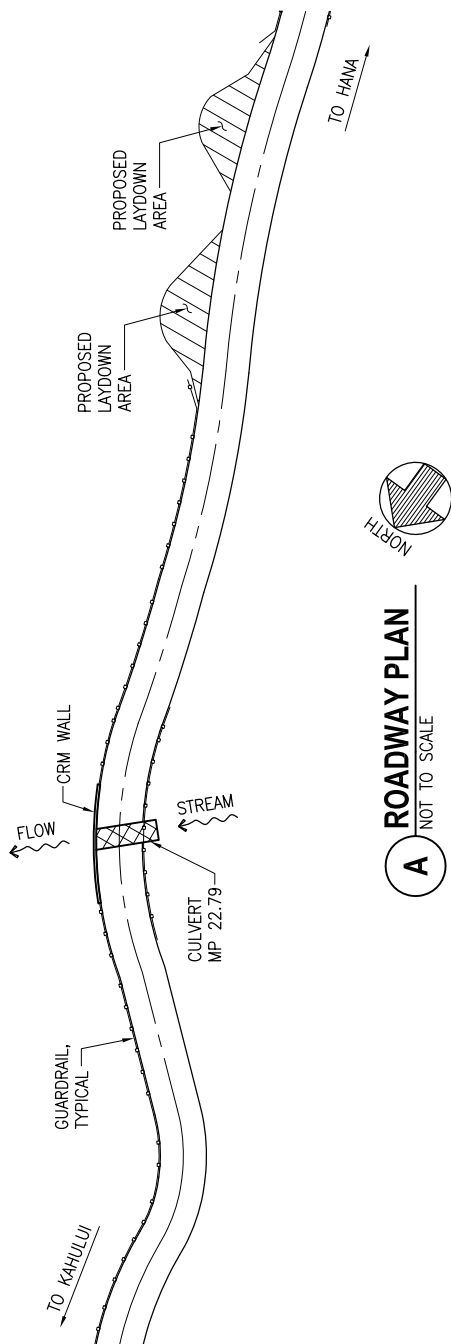
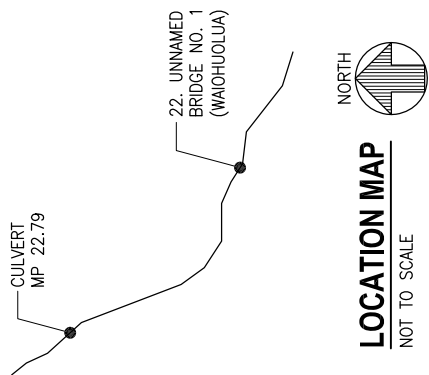
36 C	CULVERT MP 22.79			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of downstream CRM parapet.



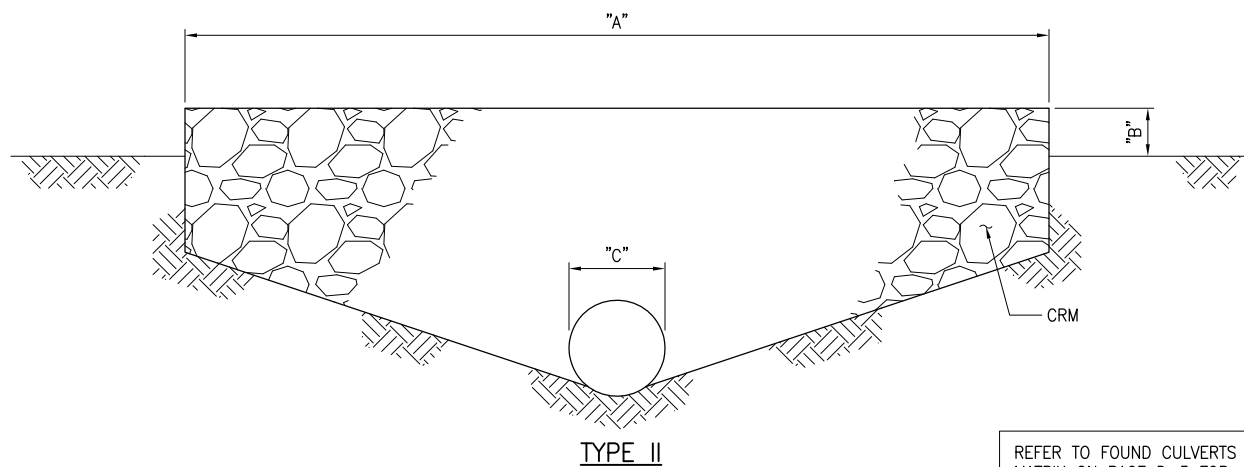
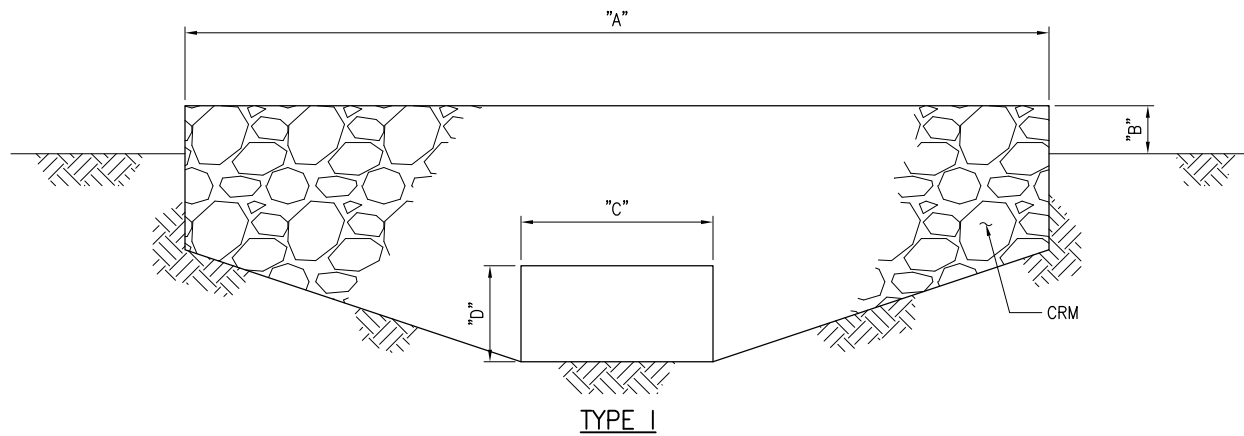
View of upstream concrete culvert headwall and CRM wingwalls.



Drawing D: 36C-1

2015

CULVERT MP 22.79



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



37 C	<b>CULVERT MP 22.90</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



<b>37</b> <b>C</b>	<b>CULVERT MP 22.90</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b>	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement

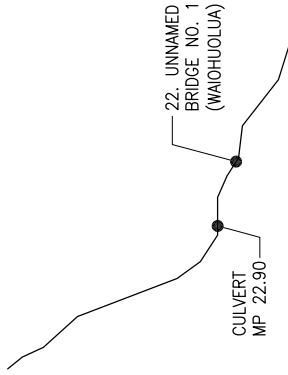


View of downstream CRM parapet.

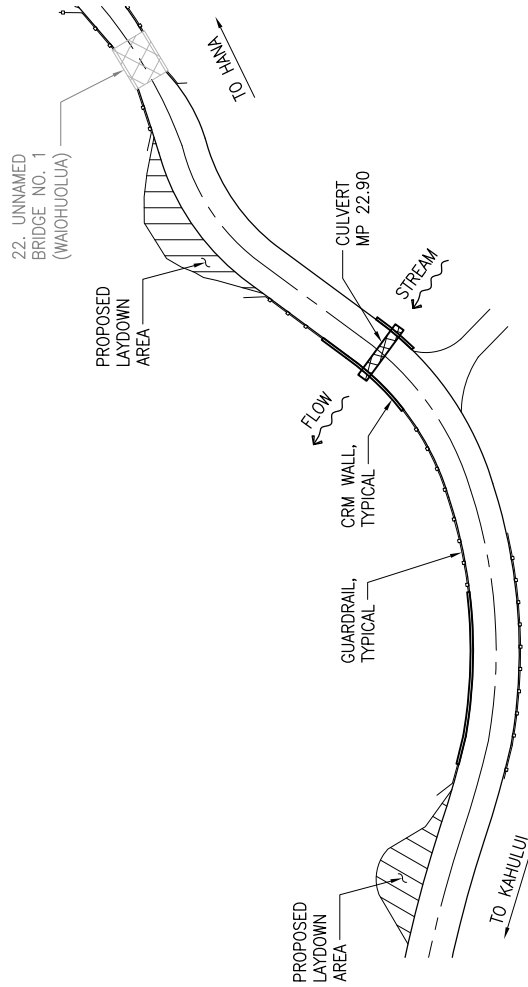


24" diameter RCP inlet at upstream side.





# **LOCATION MAP** NOT TO SCALE

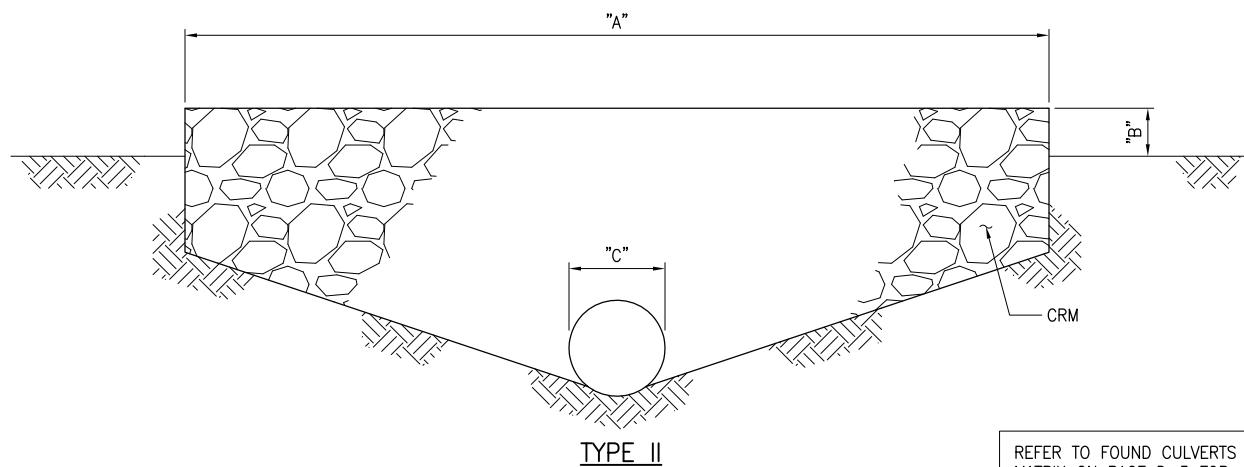
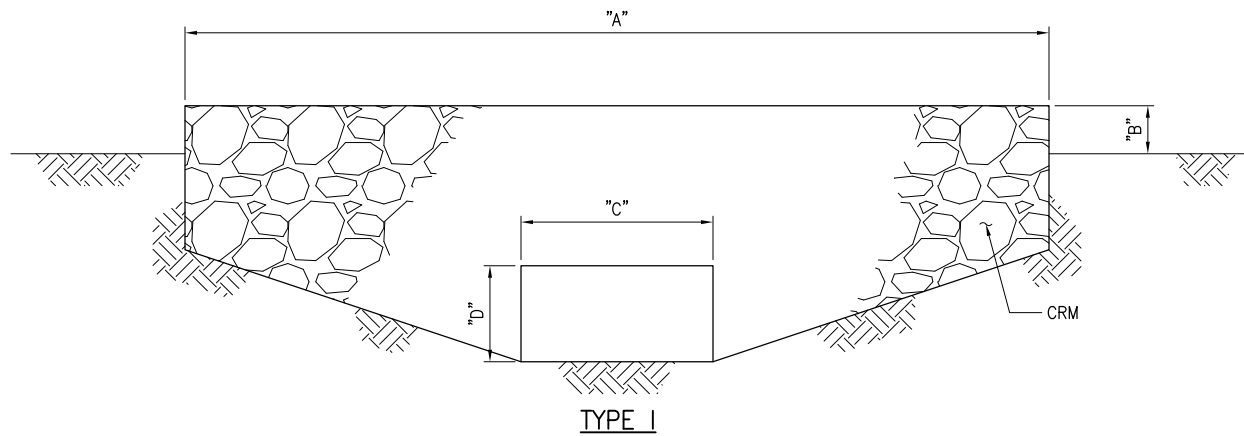


# **A ROADWAY PLAN** NOT TO SCALE

Drawing D: 37C-1

2015

CULVERT MP 22.90



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

38 C	<b>CULVERT MP 23.04</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations: <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



Kahului approach looking toward Hana.



View of upstream CRM parapet.



# 38 CULVERT MP 23.04

C

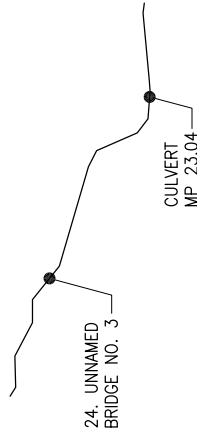
Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



View of downstream CRM parapet.

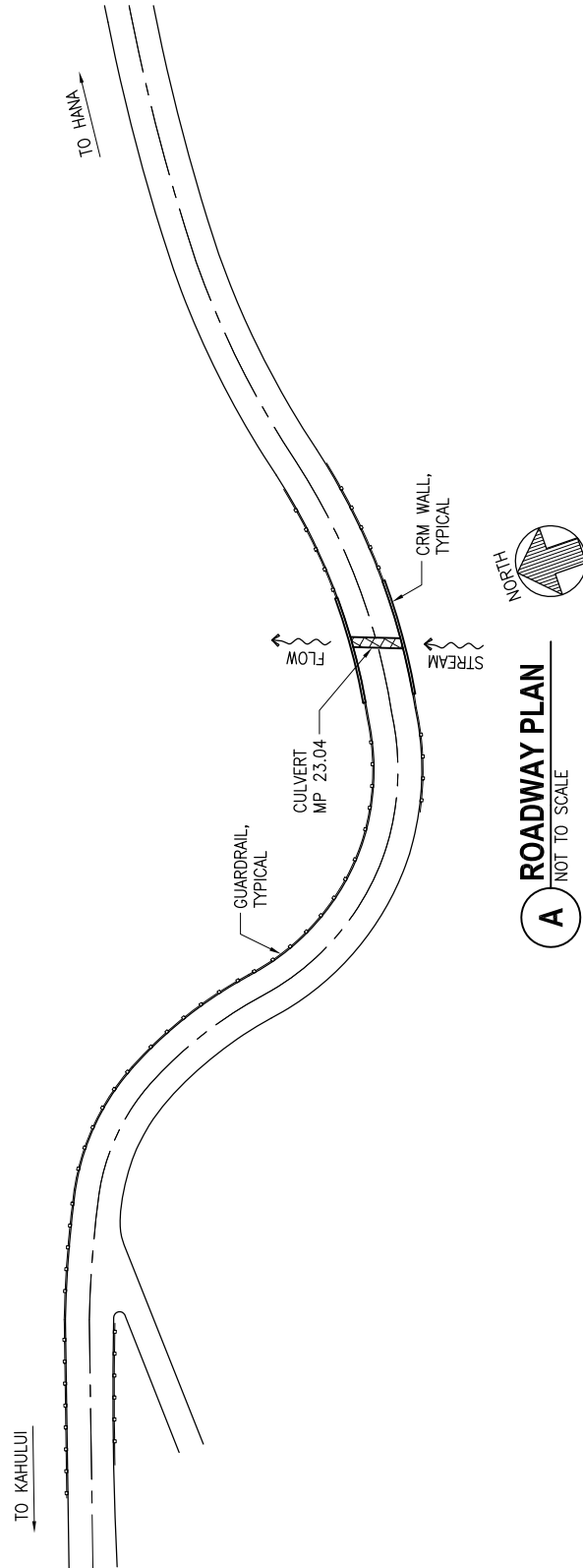


48" diameter CMP inlet at upstream side.



**LOCATION MAP**  
NOT TO SCALE

NORTH

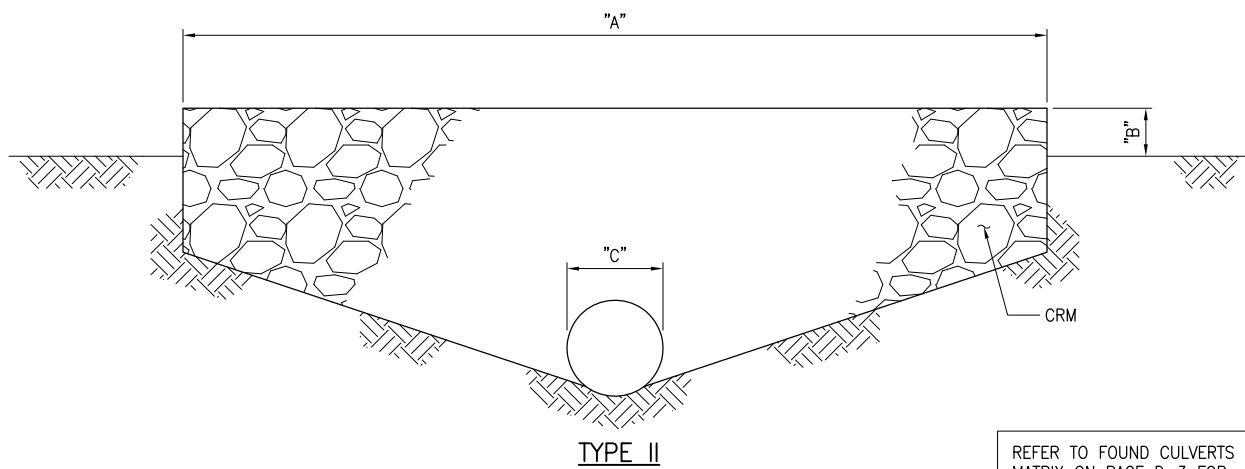
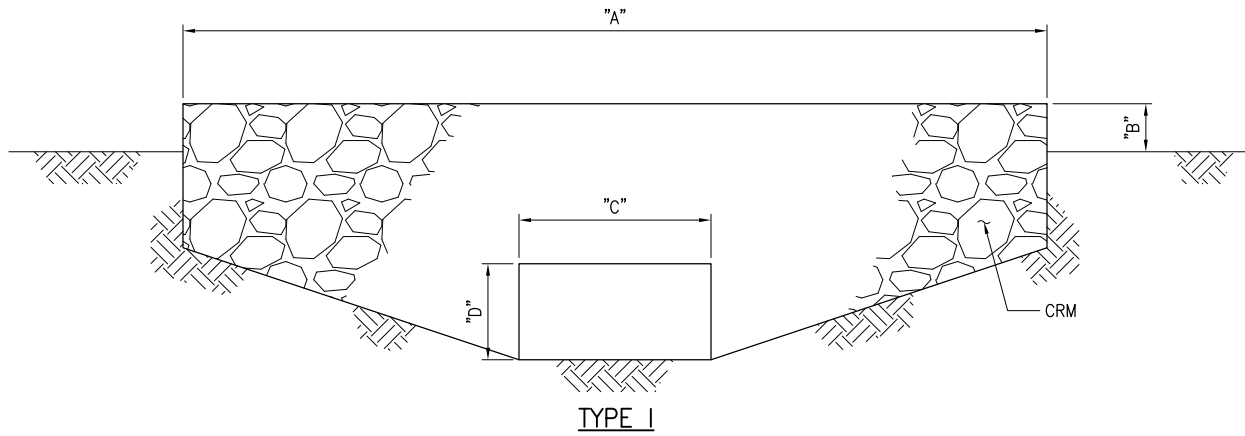


CULVERT MP 23.04

Drawing D: 38C-1

2015





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

39 C	<b>CULVERT MP 23.21</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



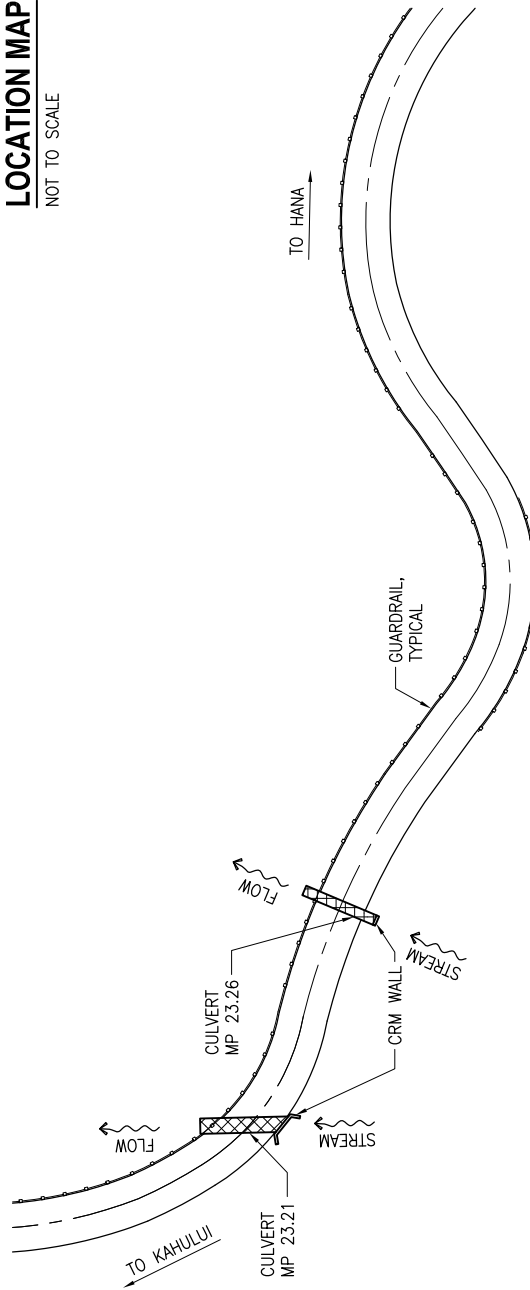
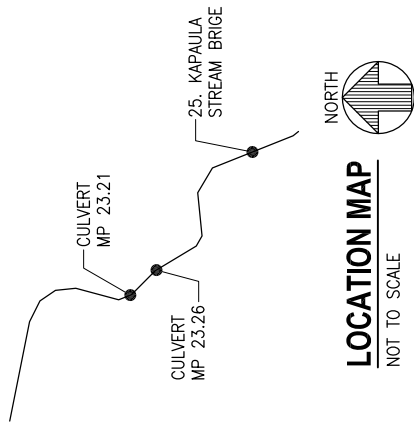
39 C	CULVERT MP 23.21				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream metal guardrail.



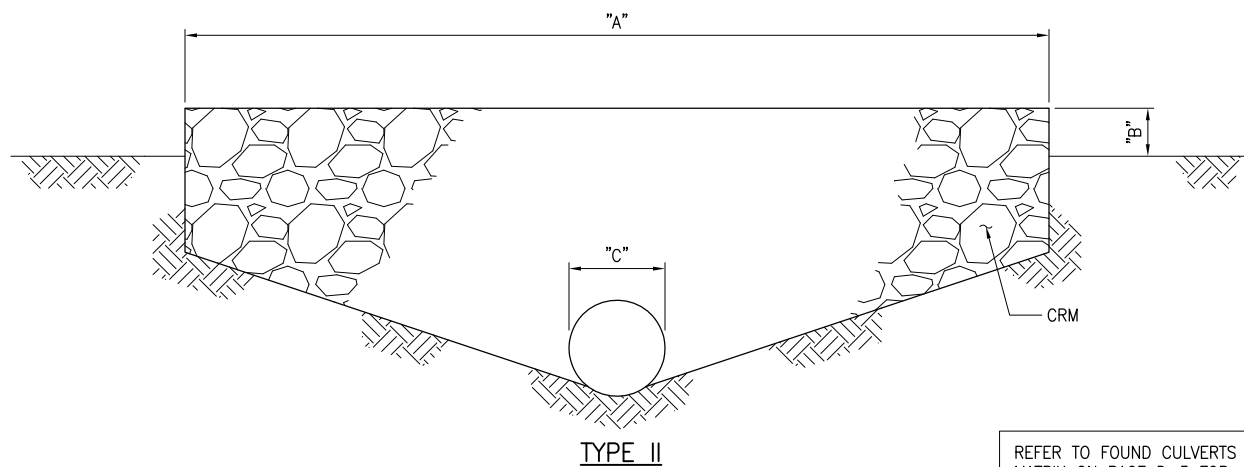
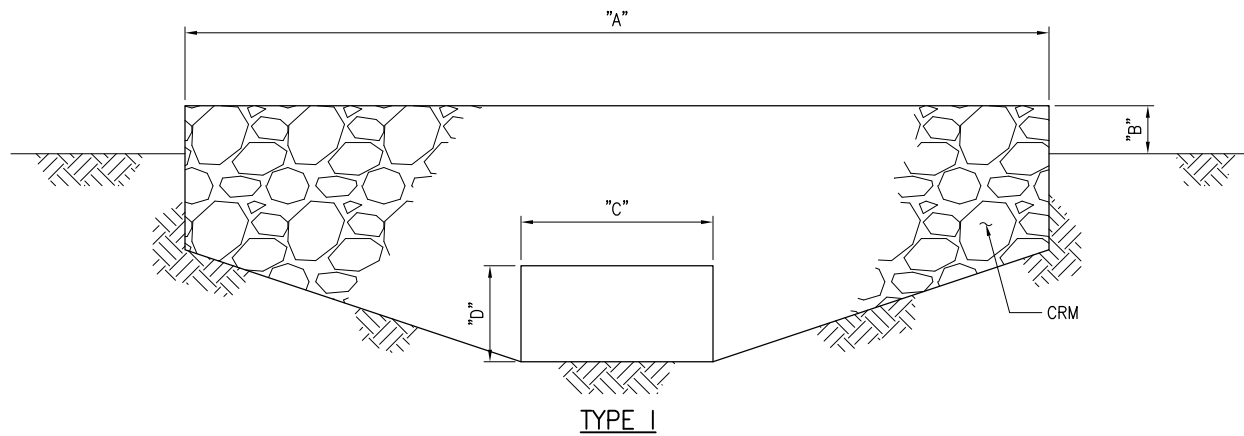
View of upstream CRM headwall / parapet and wingwalls.



Drawing D: 39C-1 & 40C-1

2015

CULVERT MP 23.21 & CULVERT MP 23.26



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



# 40 CULVERT MP 23.26

C

Bridge Number:	N/A		Island:	Maui	
Date of Construction:	Unknown		Route:	Hana Highway	
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement	



Kahului approach looking toward Hana.



View of upstream concrete parapet.



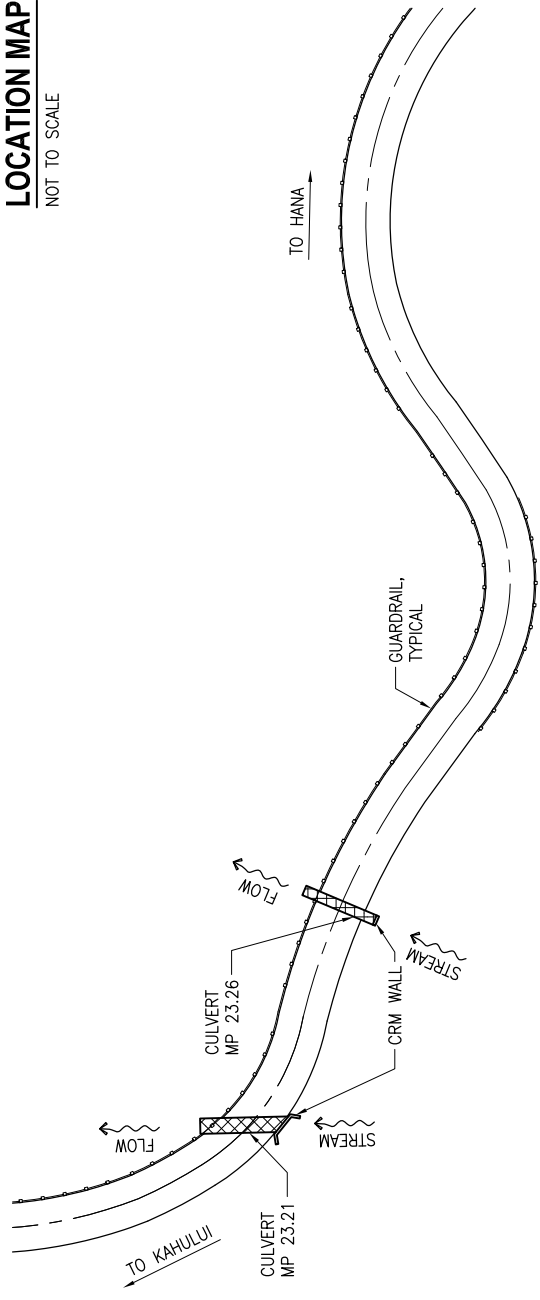
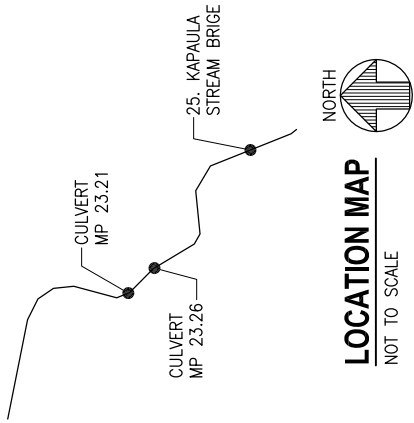
40 C	<b>CULVERT MP 23.26</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream metal guardrail.



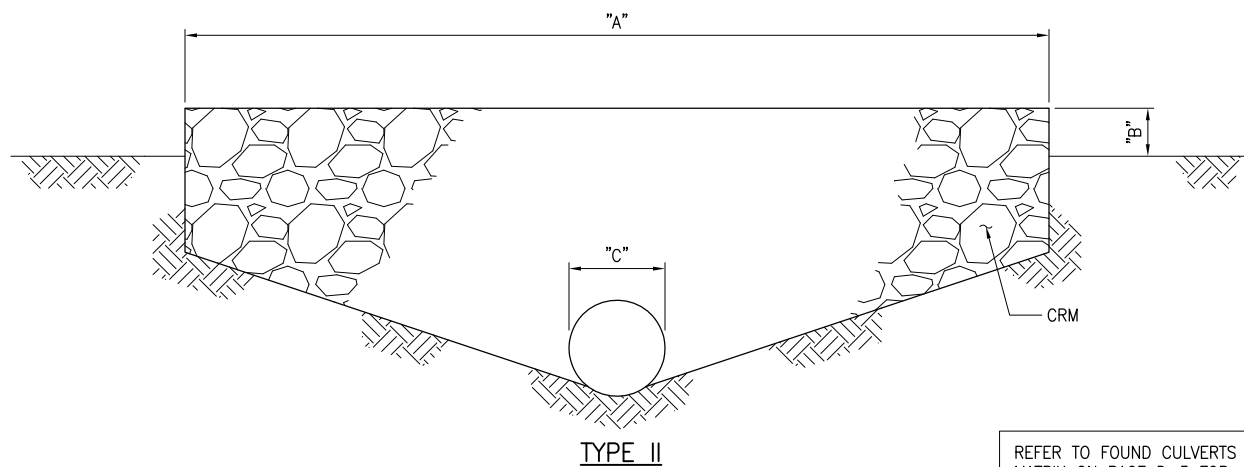
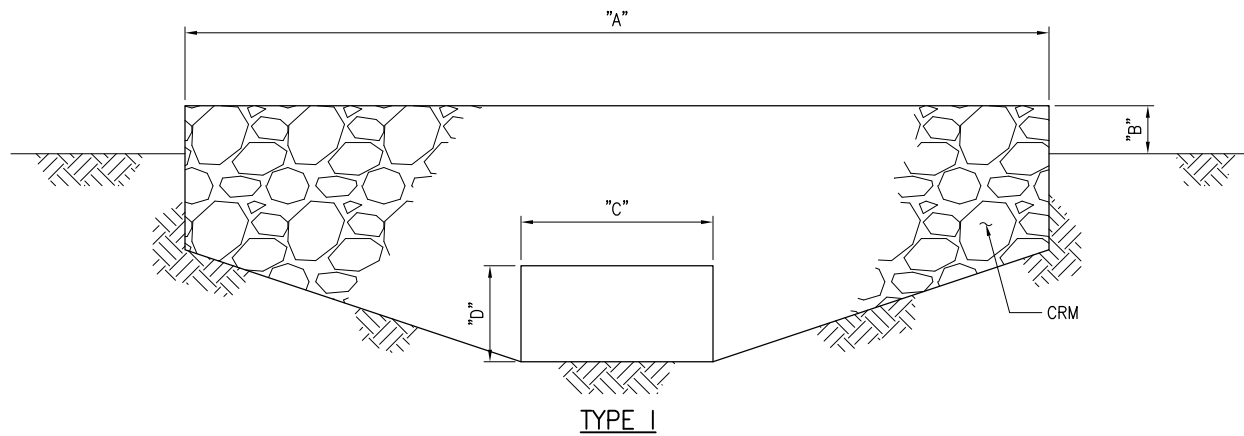
36" diameter RCP inlet at upstream side.



Drawing D: 39C-1 & 40C-1

2015

CULVERT MP 23.21 & CULVERT MP 23.26



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



41 C	<b>CULVERT MP 23.70</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana on upstream side.



View of upstream CRM parapet.



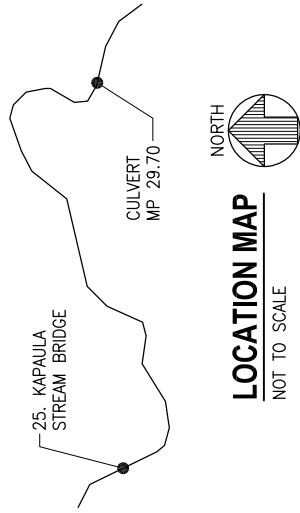
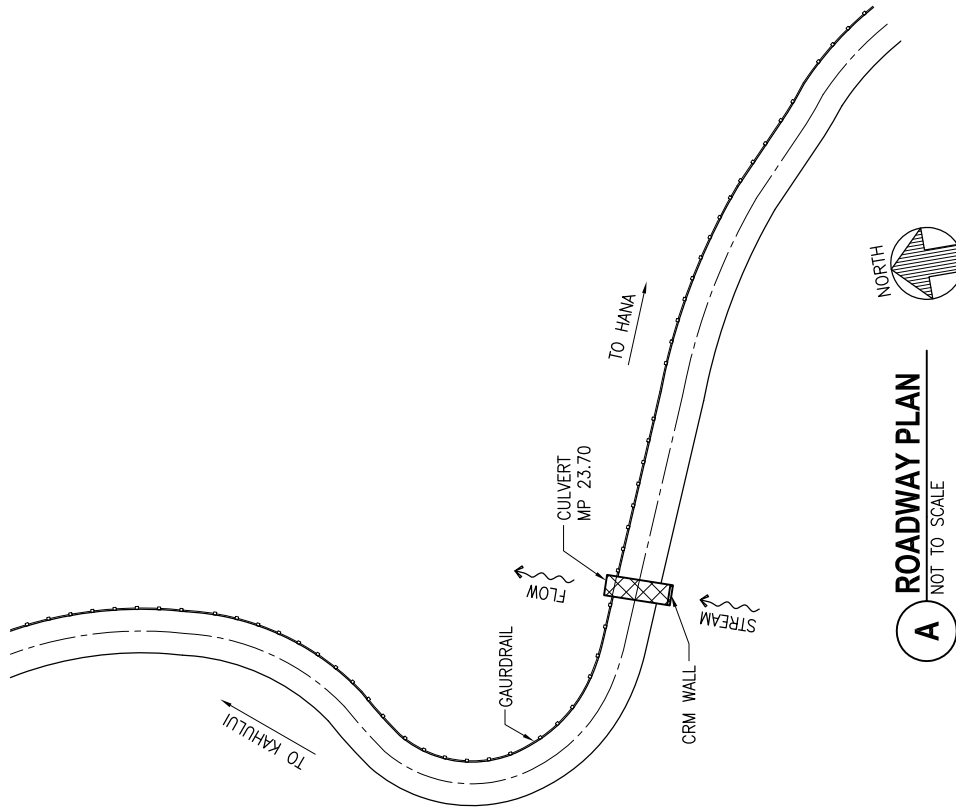
41 C	<b>CULVERT MP 23.70</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



View of downstream metal guardrail.



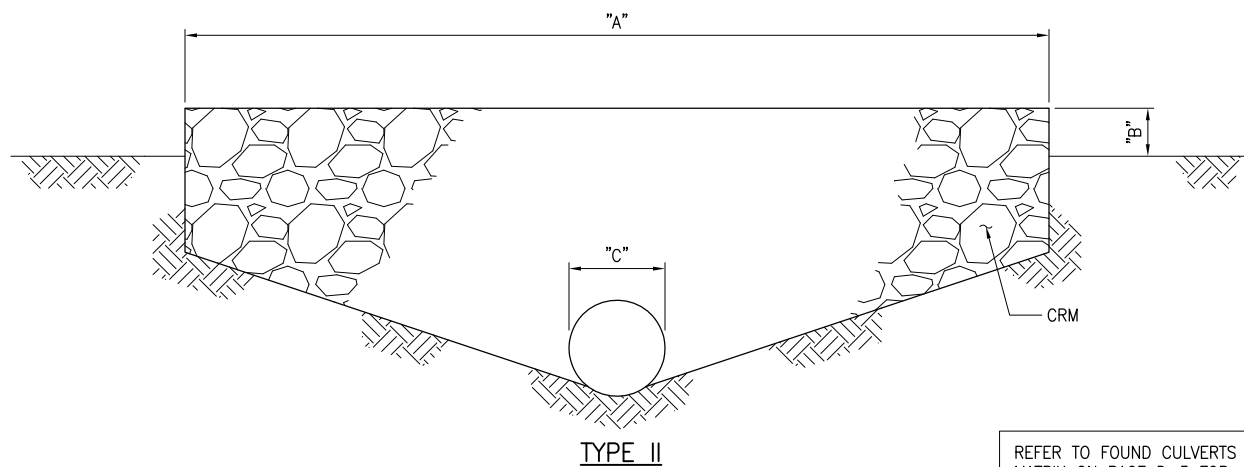
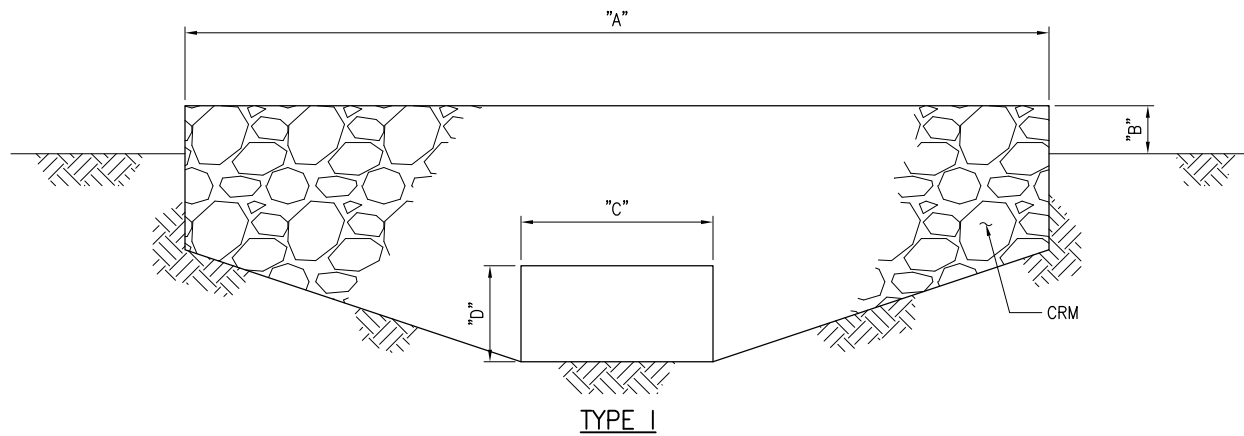
48" diameter RCP inlet at upstream side.



CULVERT MP 23.70

Drawing D: 41C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

43 C	<b>CULVERT MP 24.38</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement




Kahului approach looking toward Hana on upstream side.



View of downstream CRM parapet.

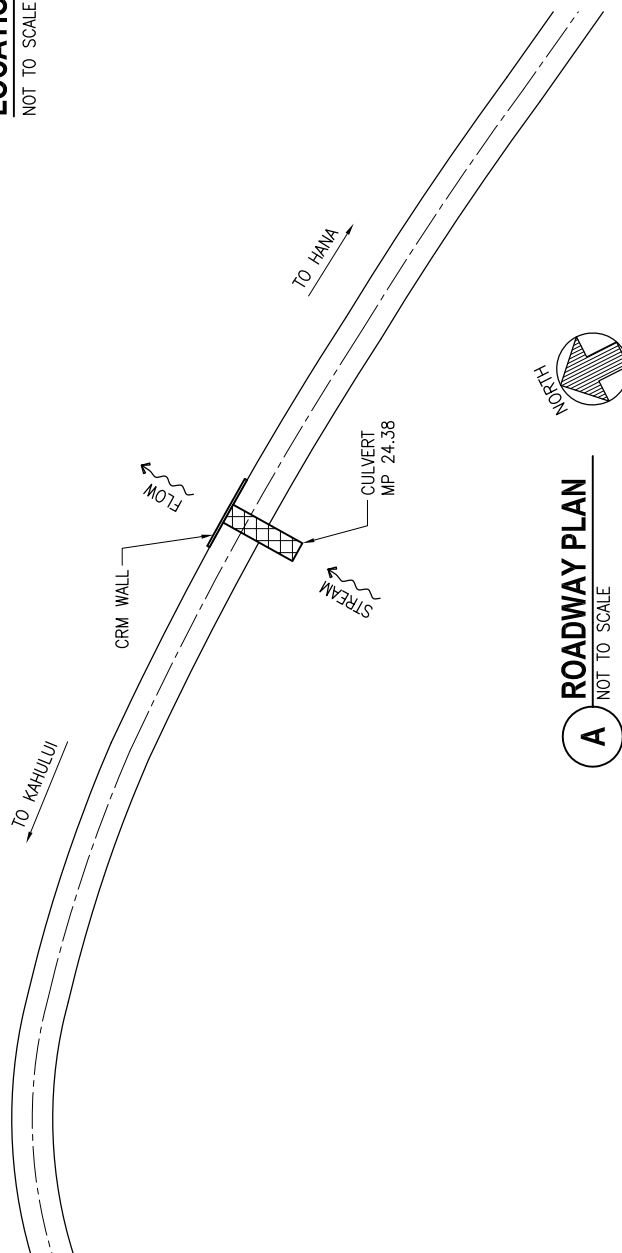


43 C	<b>CULVERT MP 24.38</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement
					
<p>24" diameter RCP outlet at downstream side.</p>					





**LOCATION MAP**  
NOT TO SCALE

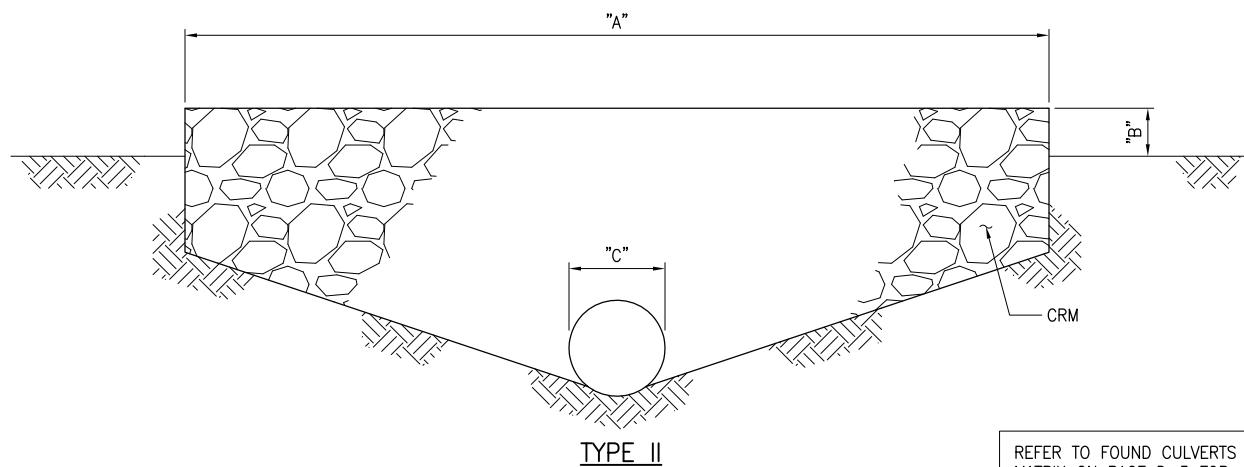
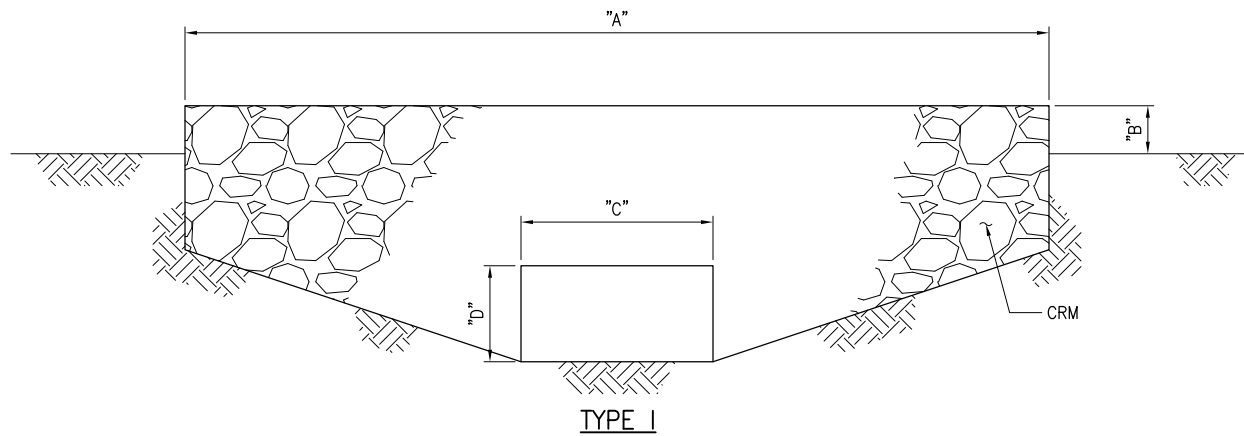


**ROADWAY PLAN**  
A NOT TO SCALE

CULVERT MP 24.38

Drawing D: 43C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

44 C	CULVERT MP 24.71				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana on upstream side.



View of downstream CRM parapet.

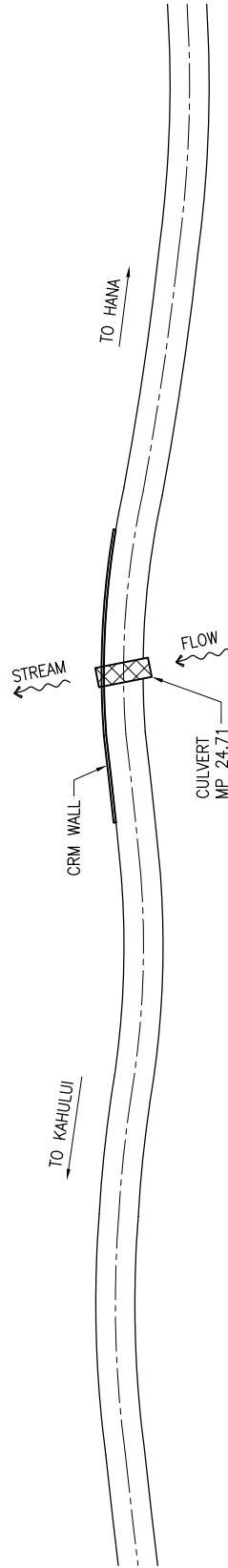
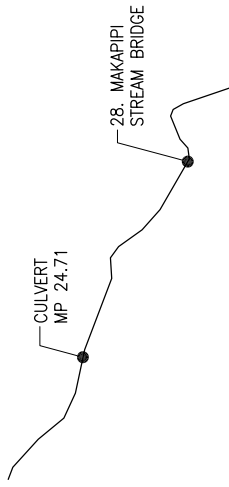
44 C	<b>CULVERT MP 24.71</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



2 - 4" diameter pipe outlets at downstream side.



View of CRM headwall / parapet at downstream side.

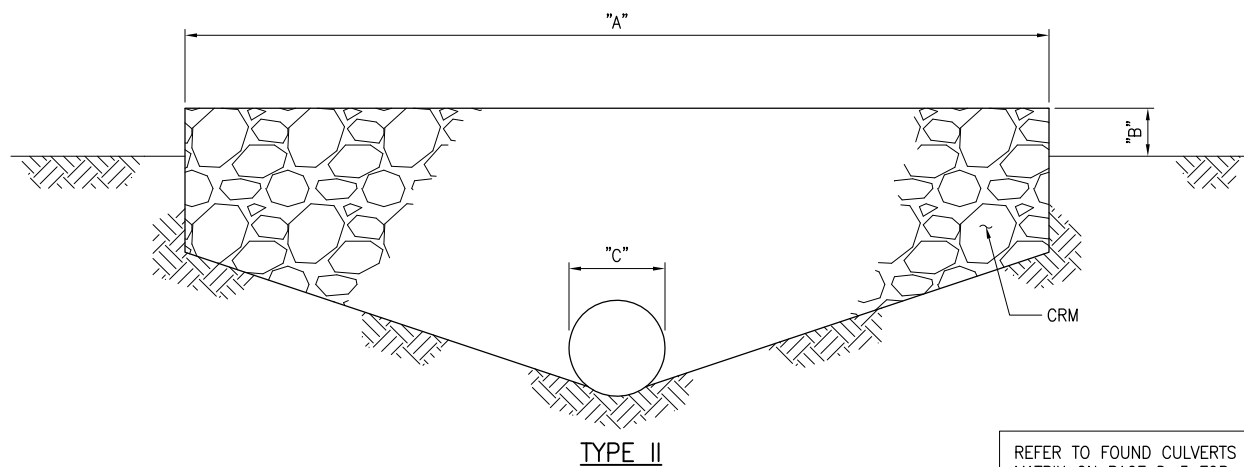
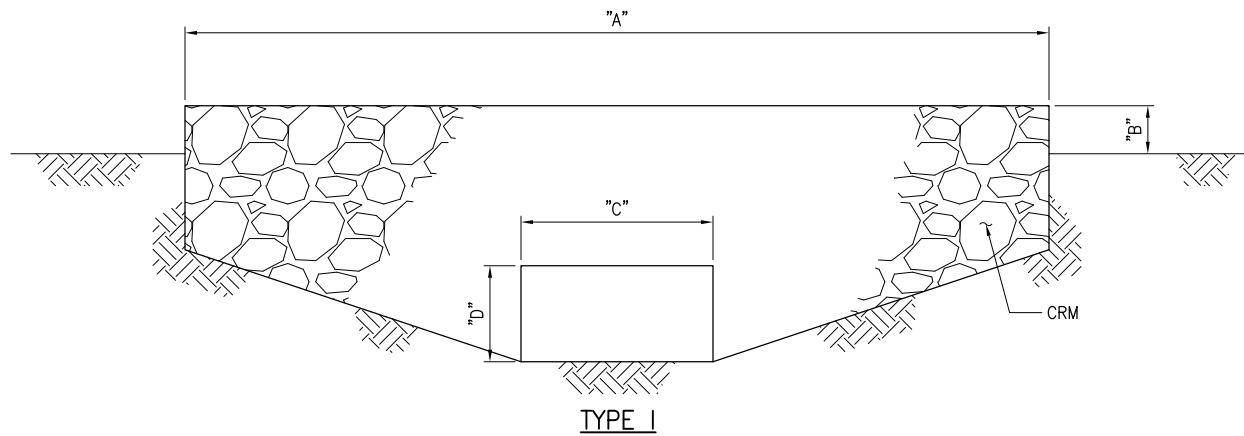


CULVERT MP 24.71

Drawing D: 44C-1

2015





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

45 C	<b>CULVERT MP 24.90</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input checked="" type="checkbox"/> Replacement



Kahului approach looking toward Hana on upstream side.

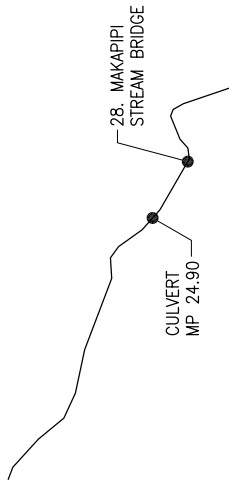


View of downstream CRM parapet.

45 C	<b>CULVERT MP 24.90</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			

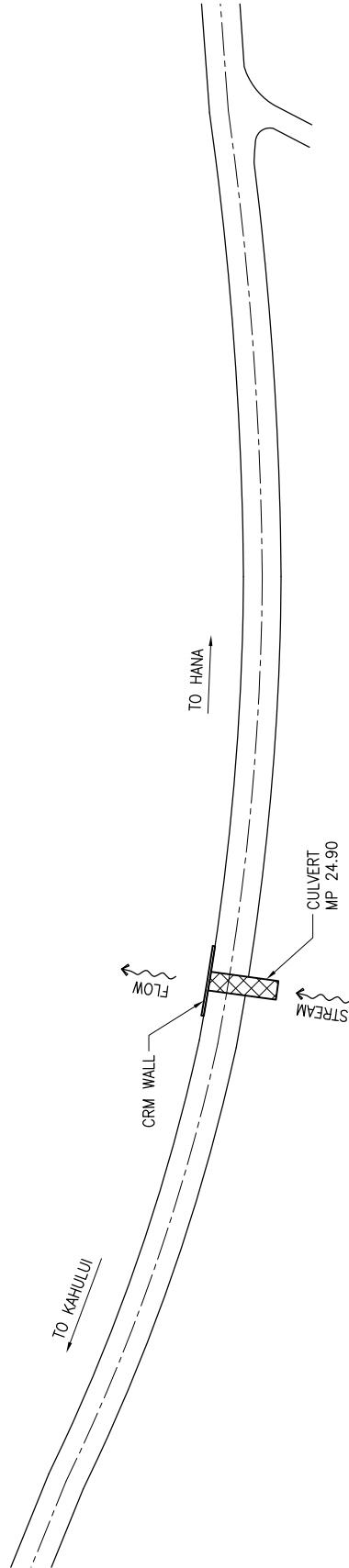


View of CRM headwall / parapet at downstream side.



**LOCATION MAP**  
NOT TO SCALE

NORTH



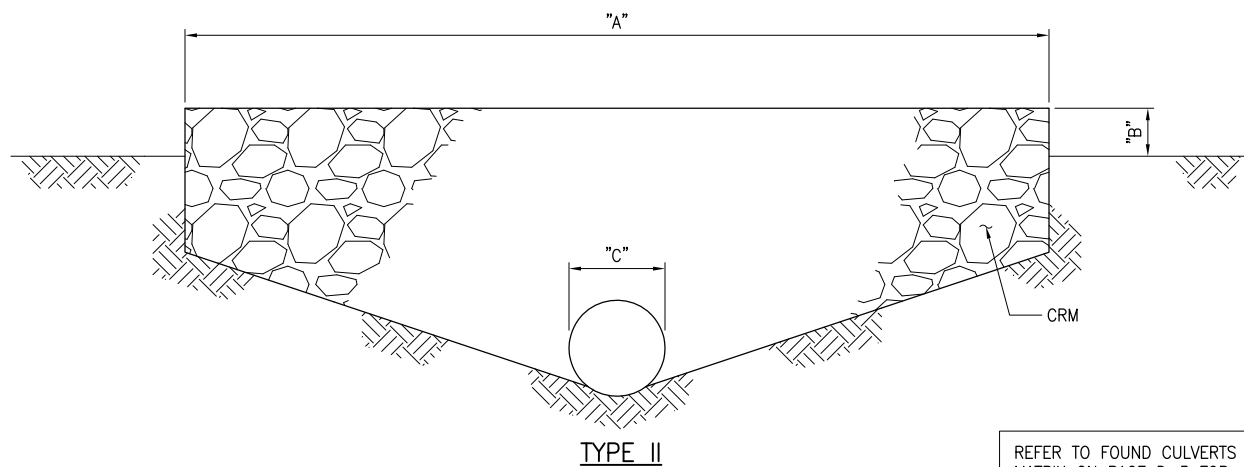
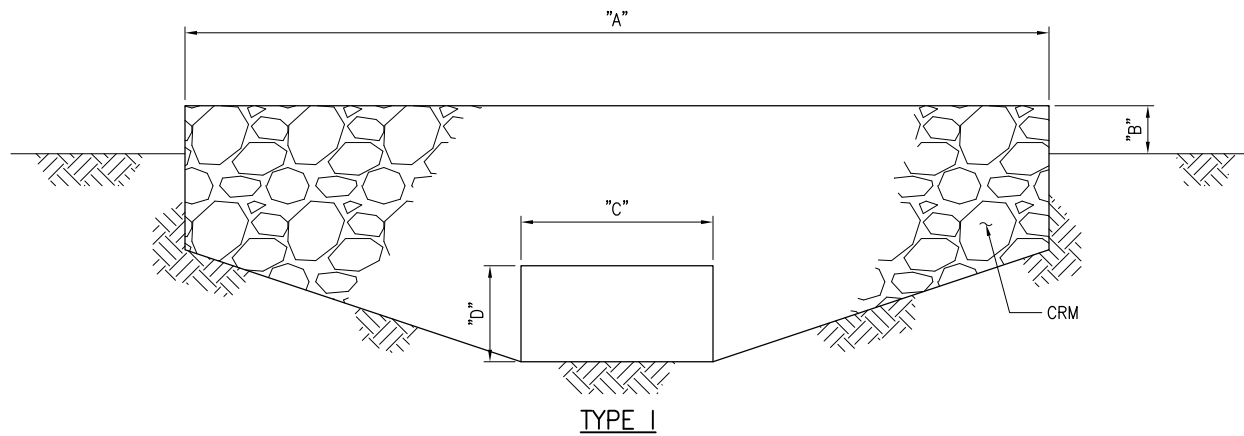
**A ROADWAY PLAN**  
NOT TO SCALE

NORTH

CULVERT MP 24.90

Drawing D: 45C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



46 C	<b>CULVERT MP 26.13</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.

46 C	<b>CULVERT MP 26.13</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement

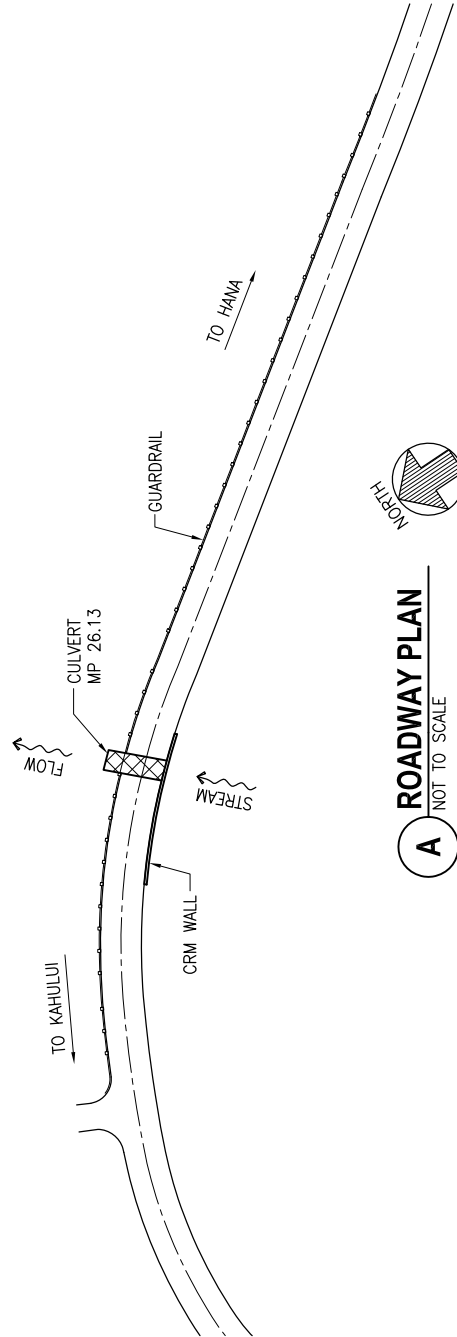
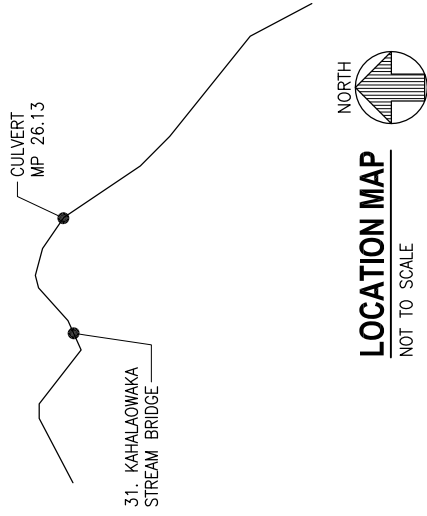


View of downstream metal guardrail.



View of CRM headwall / parapet at upstream side.

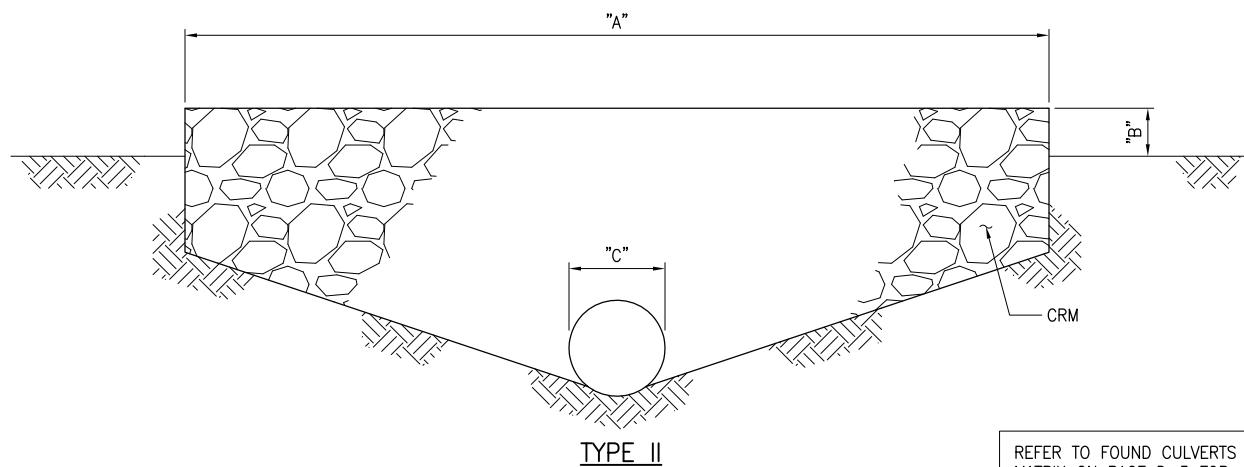
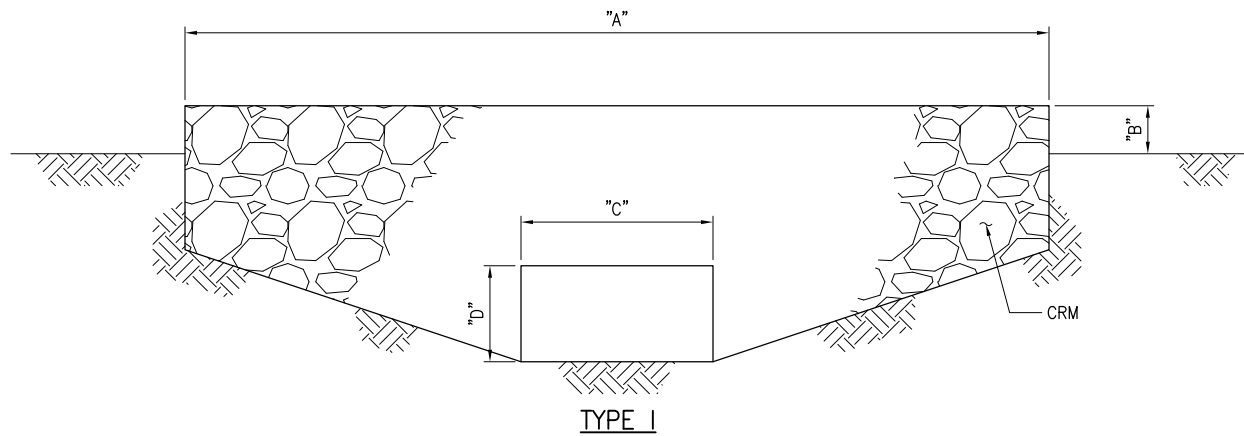




Drawing D: 46C-1

2015

CULVERT MP 26.13



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

# 47 CULVERT MP 26.33

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



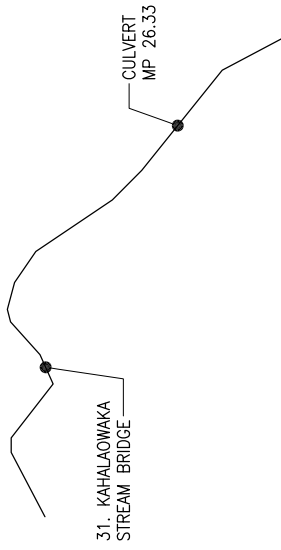
View of downstream CRM parapet.



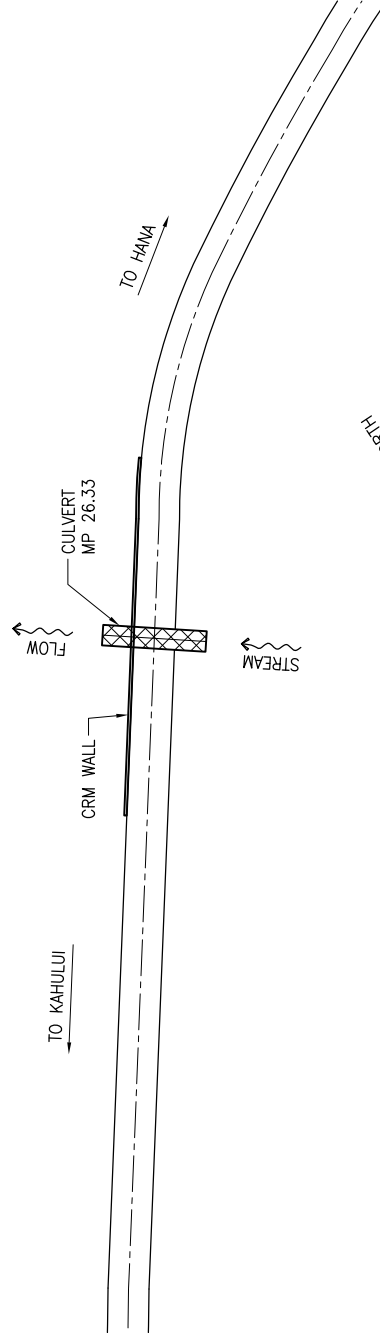
47 C	<b>CULVERT MP 26.33</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



View of downstream CRM headwall and culvert opening.



**LOCATION MAP**  
NOT TO SCALE

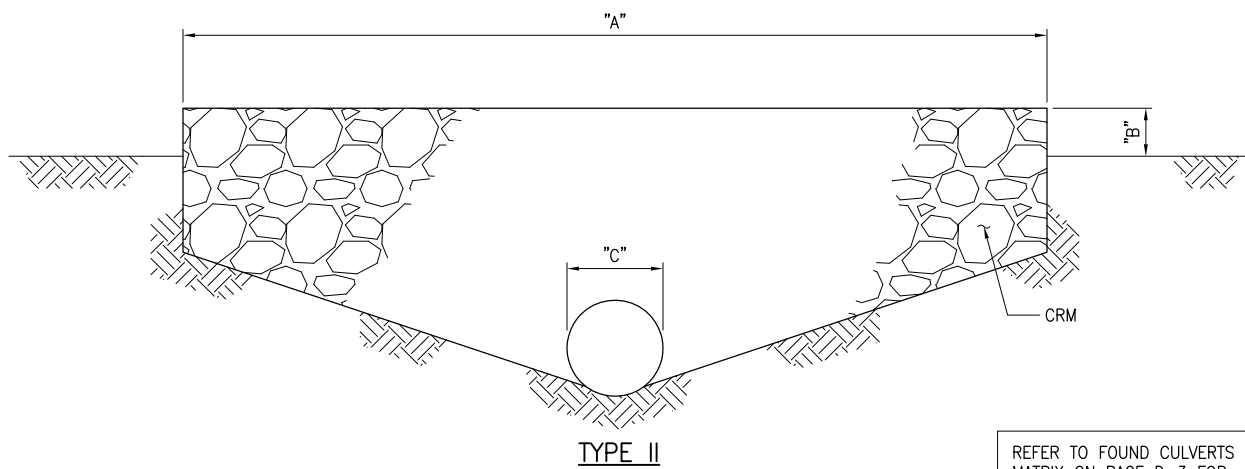
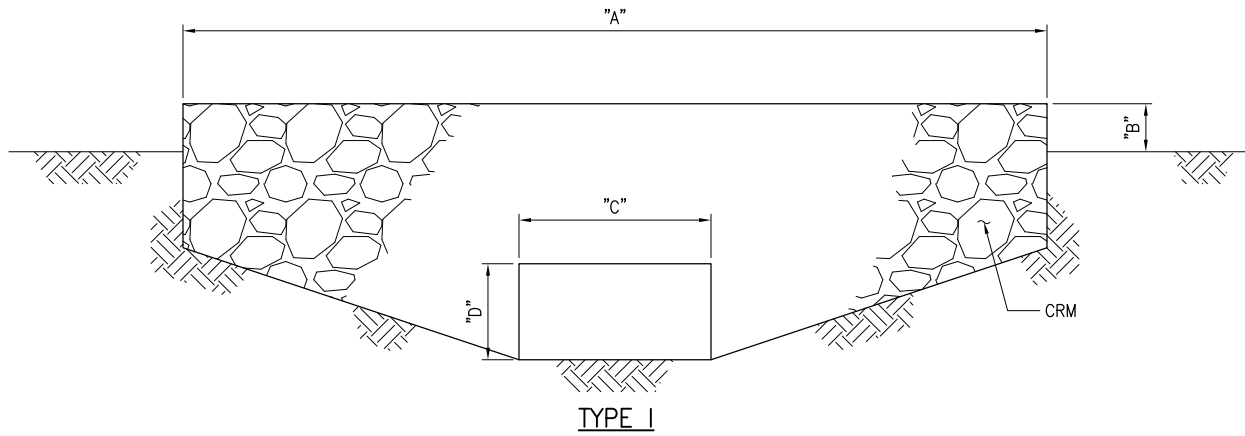


**A ROADWAY PLAN**  
NOT TO SCALE

CULVERT MP 26.33

Drawing D: 47C-1

2015



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

48 C	<b>CULVERT MP 27.26</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.



View of upstream CRM parapet.



48 C	<b>CULVERT MP 27.26</b>				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement

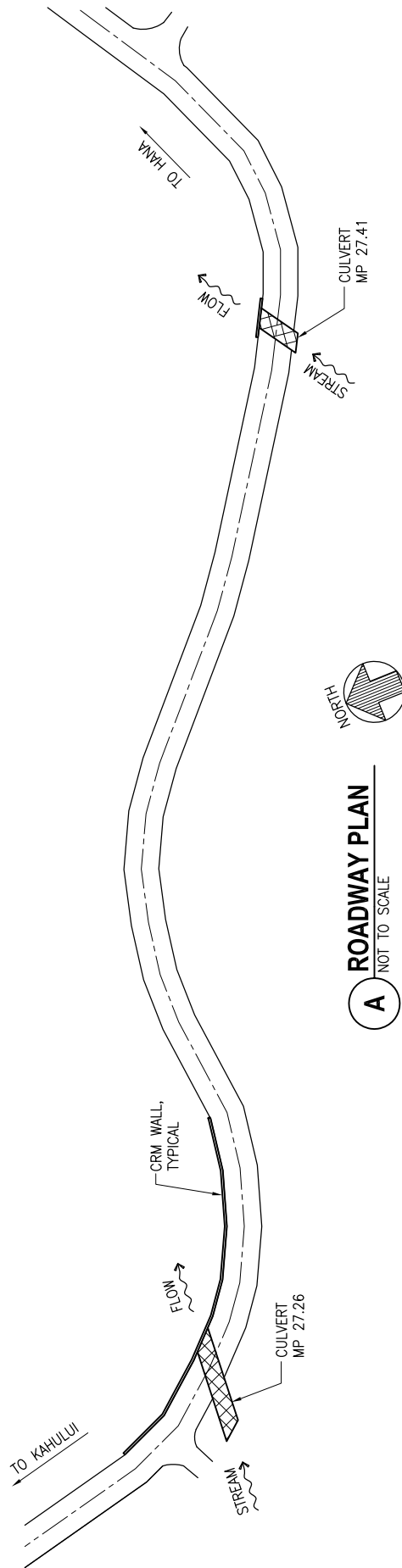
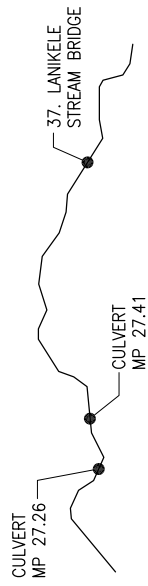


View of downstream CRM headwall / parapet covered with vegetation.



View of upstream through culvert.

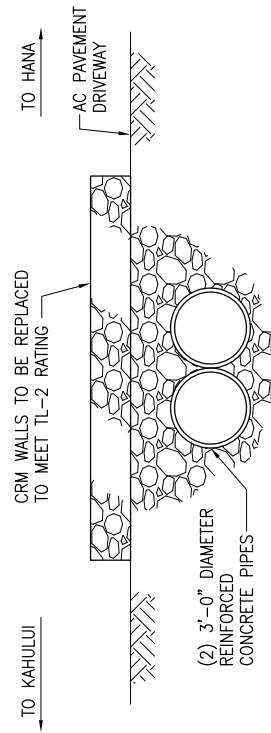




CULVERT MP 27.26 & CULVERT MP 27.41

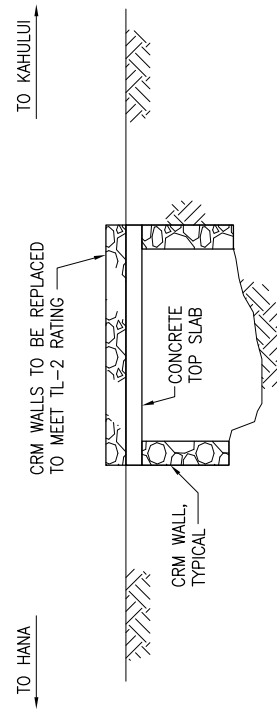
Drawing D: 48C-1 & 49C-1

2015



# 1 UPSTREAM ELEVATION

NOT TO SCALE



# 2 DOWNSTREAM ELEVATION

NOT TO SCALE

# 49 CULVERT MP 27.41

C

Bridge Number:	N/A	Island:	Maui
Date of Construction:	Unknown	Route:	Hana Highway
Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.

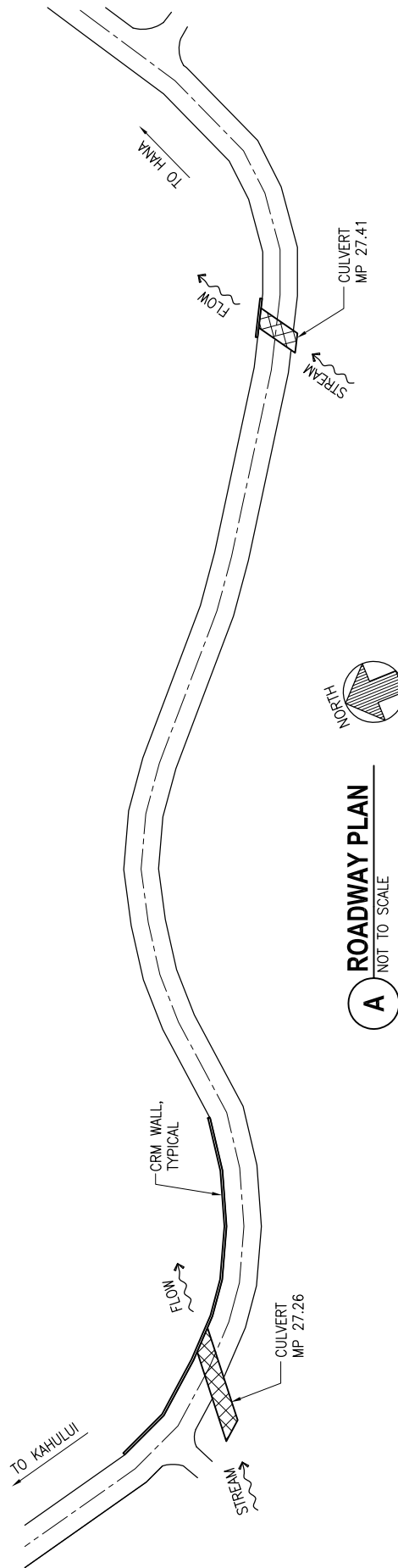
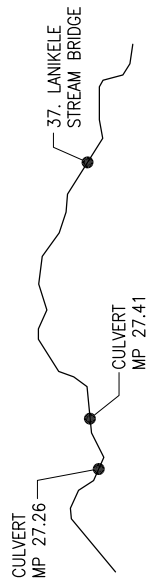


View of downstream CRM parapet.

49 C	<b>CULVERT MP 27.41</b>			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations: <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



24" diameter CMP outlet at downstream side.

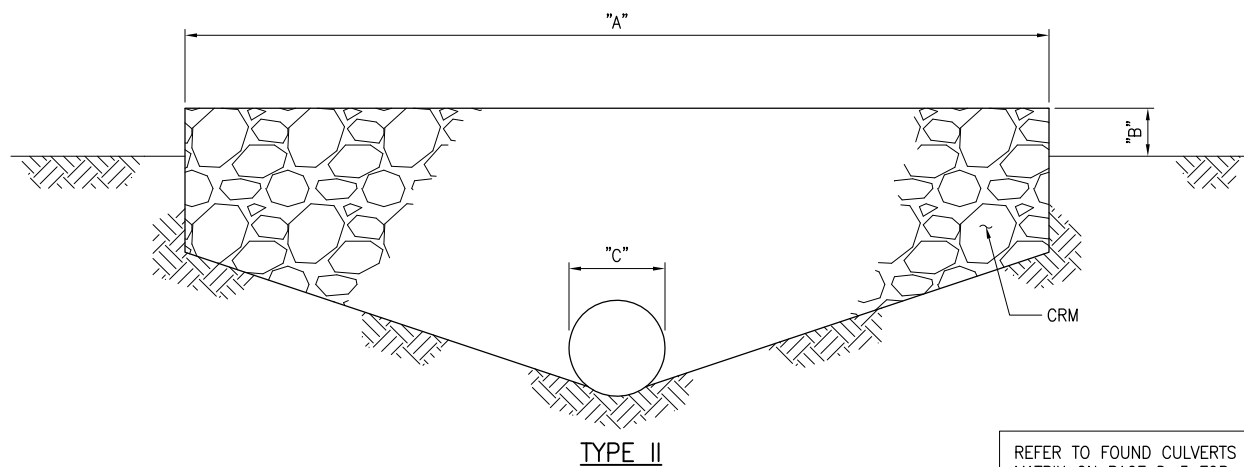
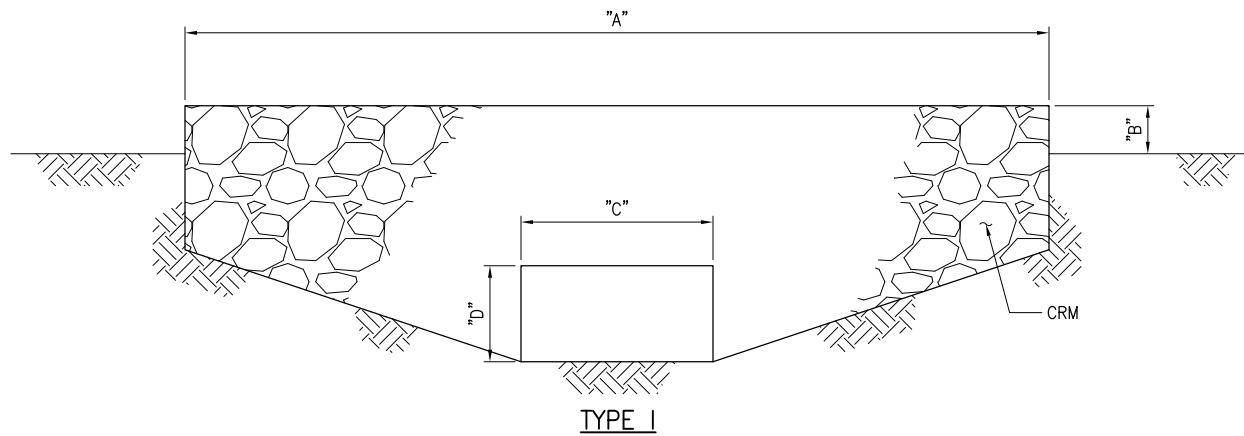


CULVERT MP 27.26 & CULVERT MP 27.41

Drawing D: 48C-1 & 49C-1

2015





REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

50 C	CULVERT MP 27.60				
	Bridge Number:	N/A		Island:	Maui
	Date of Construction:	Unknown		Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration	<input type="checkbox"/> Replacement



Kahului approach looking toward Hana.

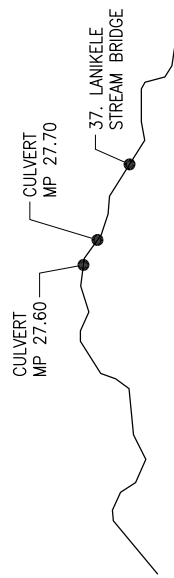


View of downstream CRM parapet.

50 C	<b>CULVERT MP 27.60</b>				
	<b>Bridge Number:</b>	N/A		<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown		<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement				

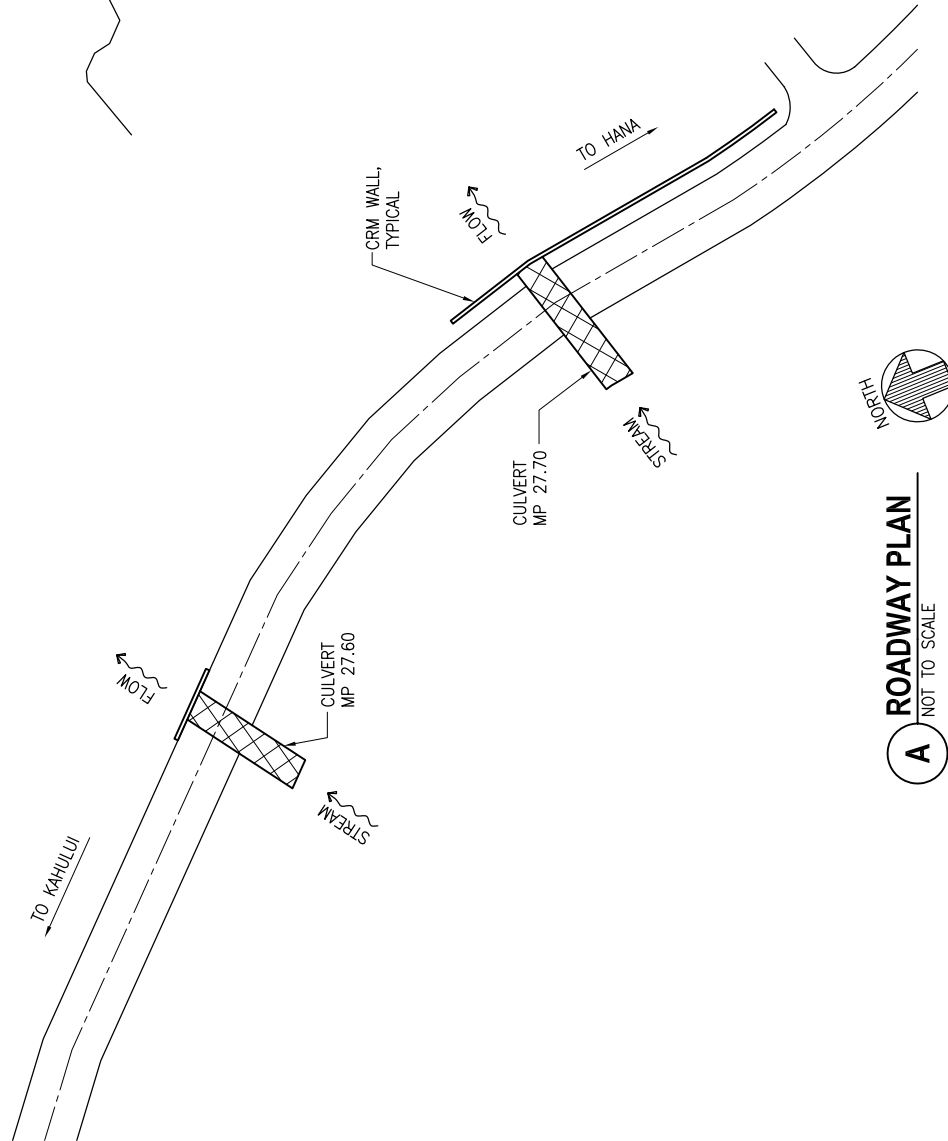


View of downstream CRM headwall / parapet.



# LOCATION MAP

NOT TO SCALE



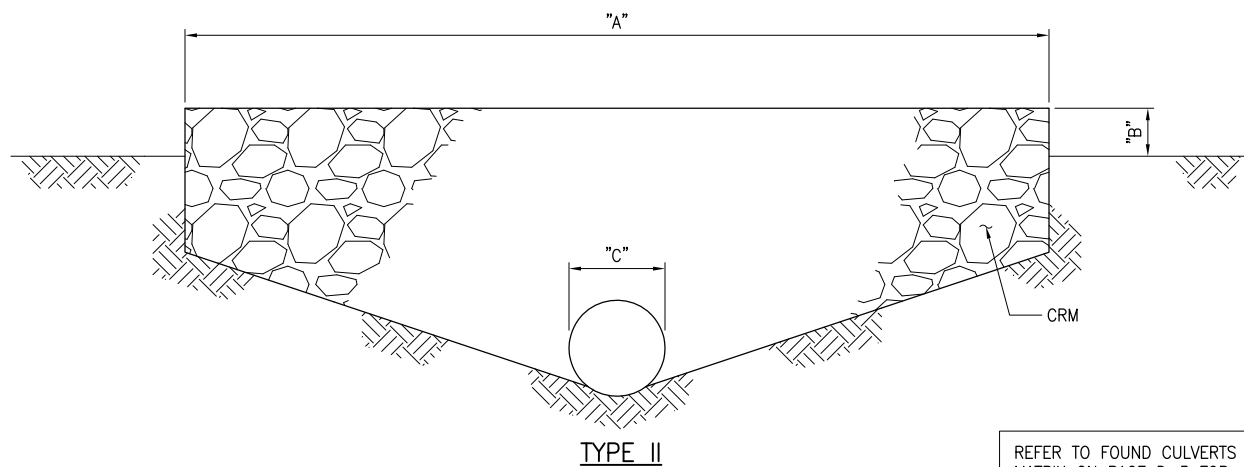
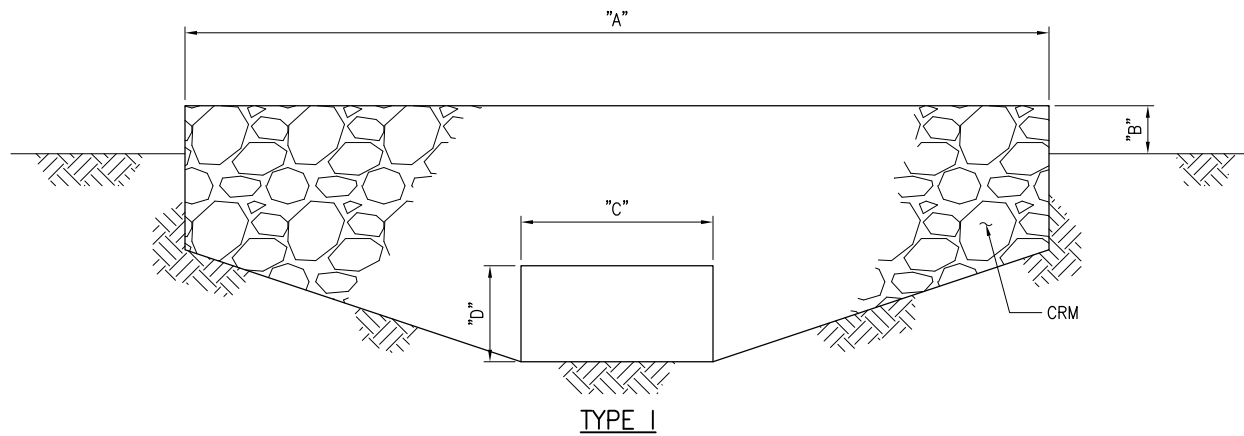
# ROADWAY PLAN

NOT TO SCALE

Drawing D: 50C-1 & 51C-1

2015

CULVERT MP 27.60 & CULVERT MP 27.70



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE



51 C	CULVERT MP 27.70			
	Bridge Number:	N/A	Island:	Maui
	Date of Construction:	Unknown	Route:	Hana Highway
	Treatment Recommendations:	<input checked="" type="checkbox"/> Preservation	<input checked="" type="checkbox"/> Rehabilitation	<input type="checkbox"/> Restoration <input type="checkbox"/> Replacement



Kahului approach looking toward Hana.

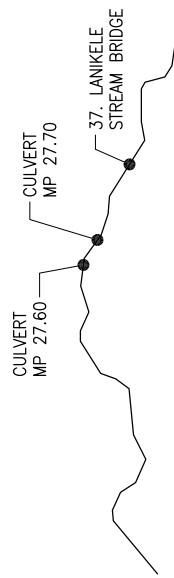


View of downstream CRM parapet.

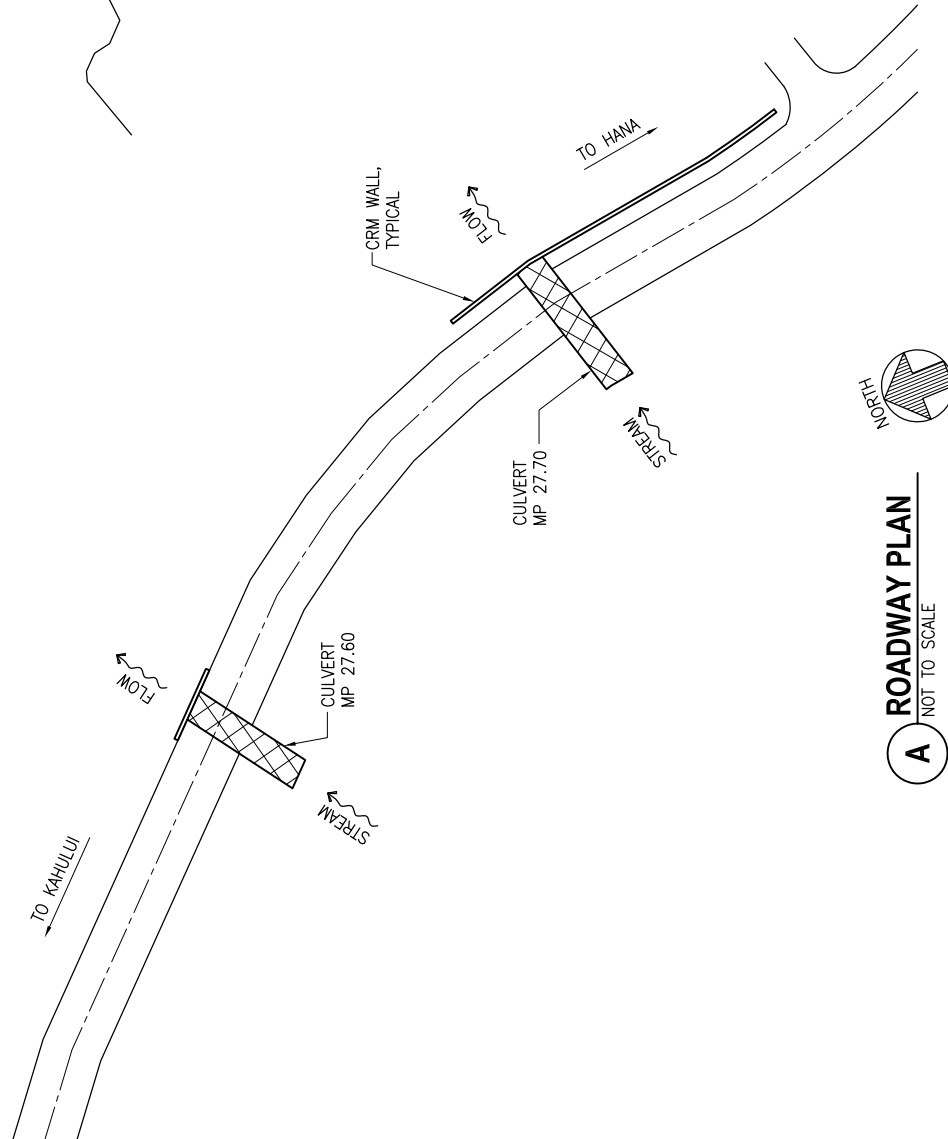
51 C	<b>CULVERT MP 27.70</b>			
	<b>Bridge Number:</b>	N/A	<b>Island:</b>	Maui
	<b>Date of Construction:</b>	Unknown	<b>Route:</b>	Hana Highway
	<b>Treatment Recommendations:</b> <input checked="" type="checkbox"/> Preservation <input checked="" type="checkbox"/> Rehabilitation <input type="checkbox"/> Restoration <input type="checkbox"/> Replacement			



View of downstream CRM headwall / parapet.



**LOCATION MAP**  
NOT TO SCALE

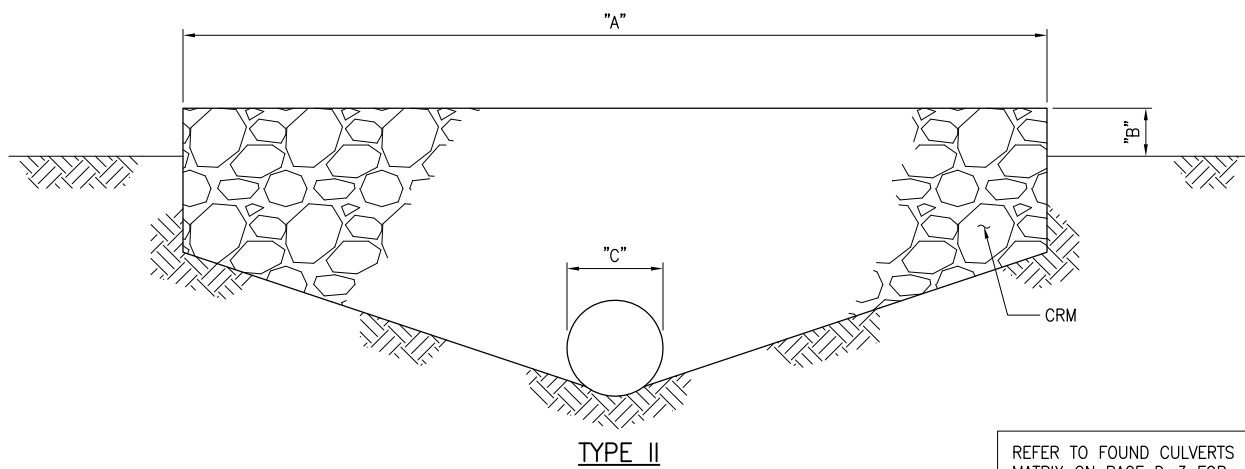
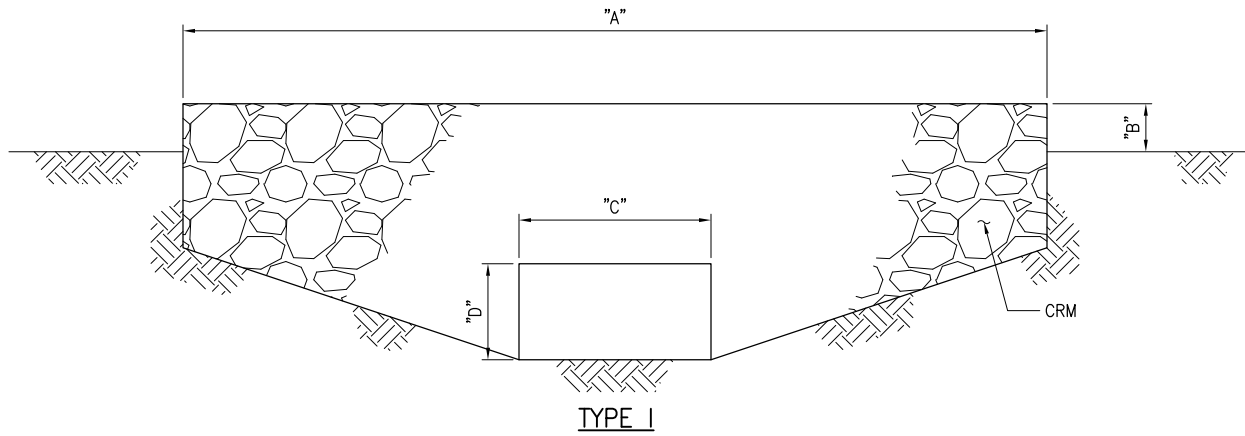


**A ROADWAY PLAN**  
NOT TO SCALE

Drawing D: 50C-1 & 51C-1

2015

CULVERT MP 27.60 & CULVERT MP 27.70



REFER TO FOUND CULVERTS  
MATRIX ON PAGE D-3 FOR  
DIMENSION VALUES.

**1** **TYPICAL ELEVATION**  
NOT TO SCALE

# **SECTION E**

## **HILLSIDE BRIDGES**





## HILLSIDE BRIDGES OVERVIEW

Along the Hana Highway, Route 360, there are seven hillside bridges. These bridges are cantilevered off of the mountain side and were constructed for the purpose of widening the existing roadway. According to record drawings,<sup>1, 2, 3</sup> Hillside Bridges #1, 2, 3, 4, 6, and 7 were constructed in 2001 and Hillside Bridge #5 was built in 2004. Per record drawings, all railings were designed for TL-2 crash standards.

Routine inspections for Maui HDOT were conducted on all the hillside bridges during the months of November and December of 2013. Hillside Bridges #1, 2, and 4 are *functionally obsolete* with a rating of 2 for *deck geometry*. Hillside Bridges #5 and 6 are also *functionally obsolete* with a rating of 3 for *deck geometry*. Hillside Bridges #3 and #7 are not *functionally obsolete*. None of the hillside bridges are *structurally deficient*.

A 10-ton load posting sign is located between mile points 2 and 3 of Hana Highway, Route 360; however, per record drawings, all hillside bridges were designed for HL-93 loads.

As mentioned above, Hillside Bridges #1, 2, 4, 5, and 6 are *functionally obsolete*; however, no repair or rehabilitation recommendations are suggested for the bridges at this time. Additionally, no repair or rehabilitation recommendations are suggested for Hillside Bridges #3 and #7 at this time.

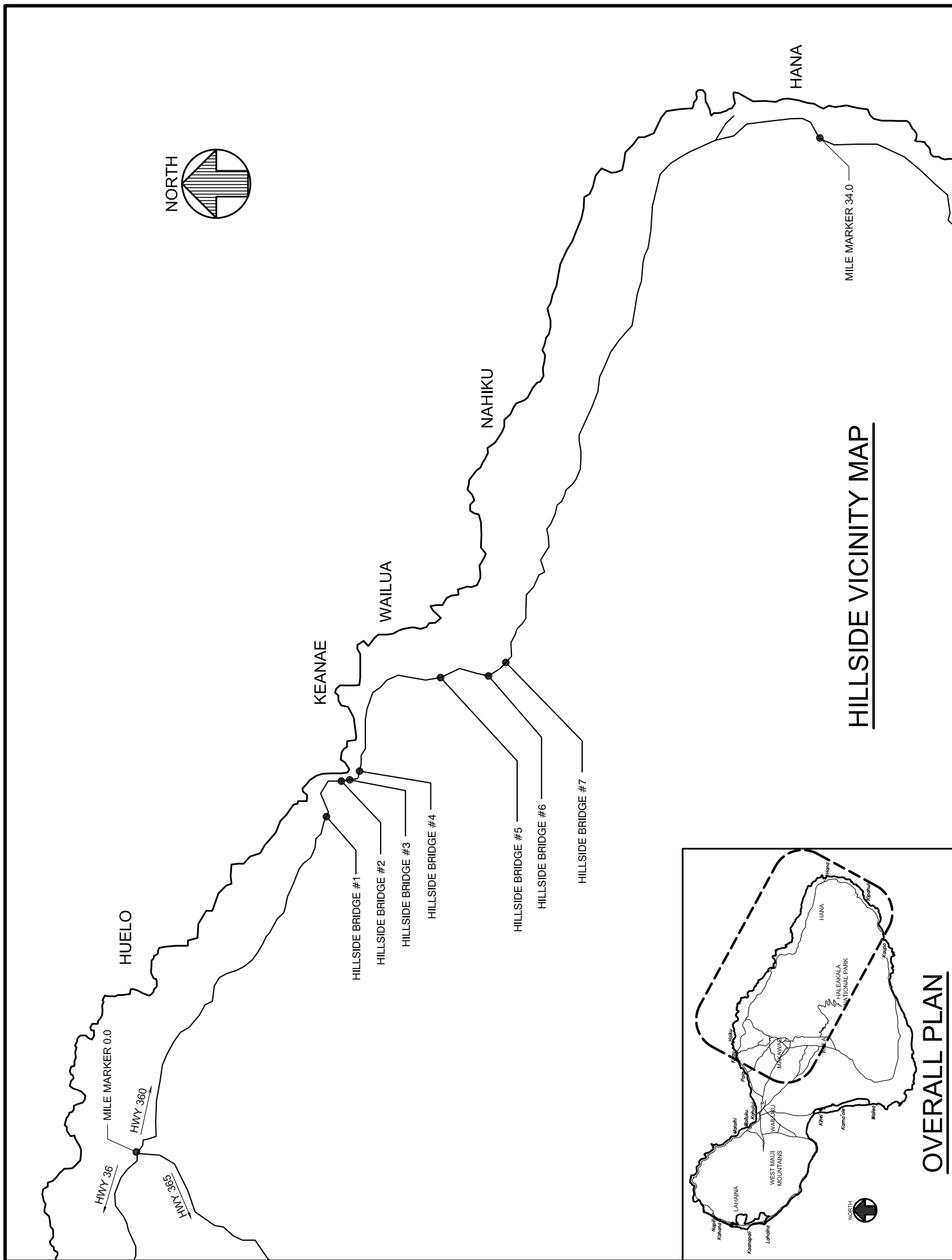
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<sup>1</sup> State of Hawaii, Department of Transportation, Highways Division, *Hana Highway Emergency Federal-Aid Project Roadway Repairs at Various Locations*, February 2001.

<sup>2</sup> State of Hawaii, Department of Transportation, Highways Division, *Hana Highway Repairs and Maintenance at Various Locations, Phase-I*, March 2001.

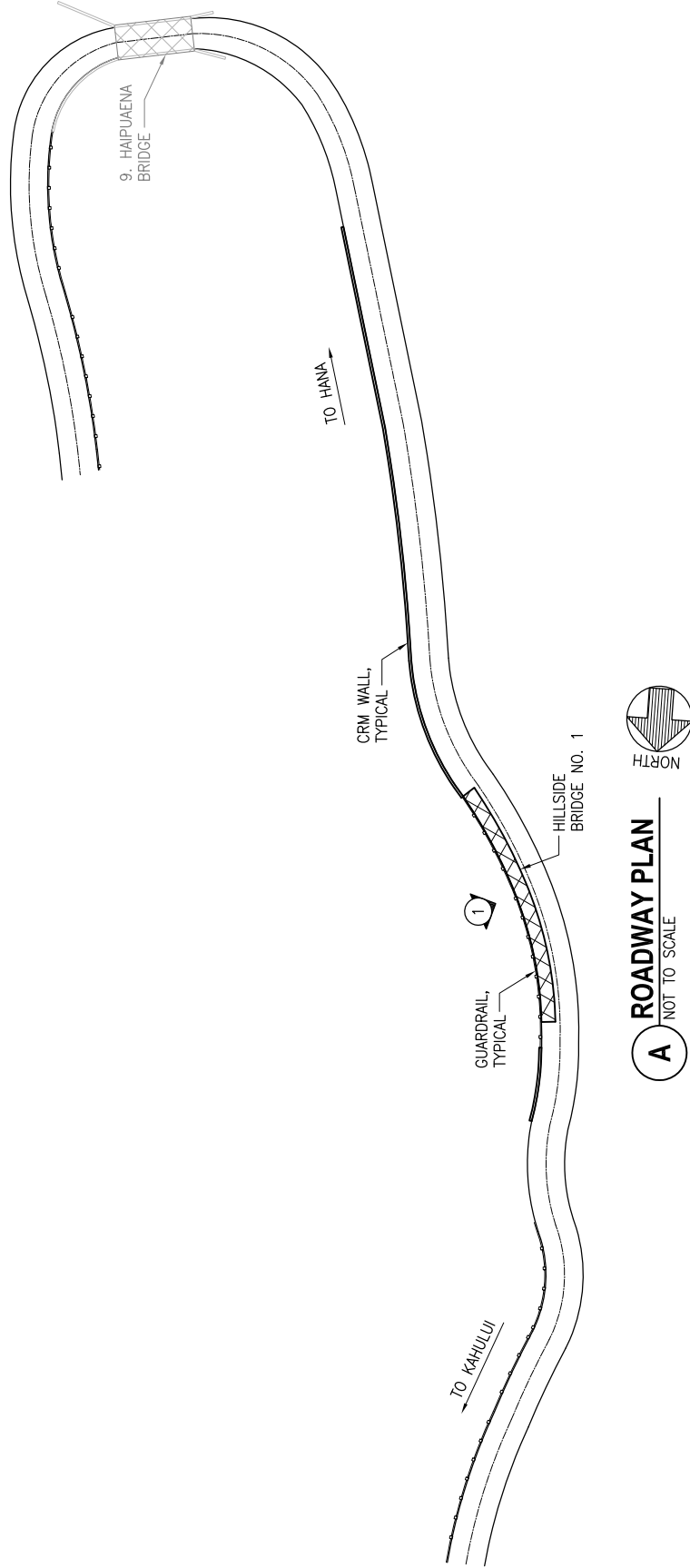
<sup>3</sup> State of Hawaii, Department of Transportation, Highways Division, *Route 360 Hana Highway Repairs and Maintenance, Phase-3*, April 2004.





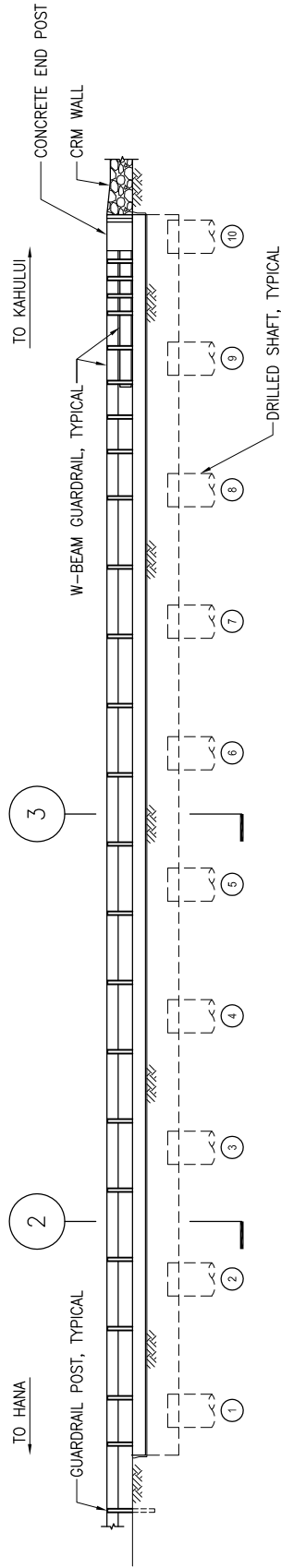






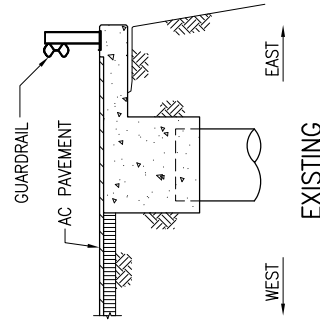
HILLSIDE BRIDGE NO. 1 (MP 11.40)  
Structure Number: 009003600501140

Drawing E 1-1  
2015



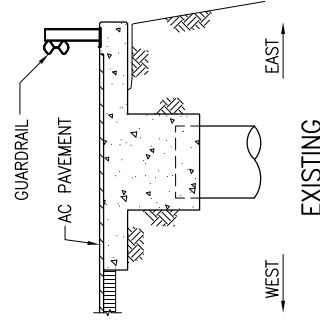
### 1 EAST ELEVATION

NOT TO SCALE



### 2 SECTION TYPICAL AT DRILLED SHAFT 1 & 2

NOT TO SCALE



### 3 SECTION TYPICAL AT DRILLED SHAFT 3-10

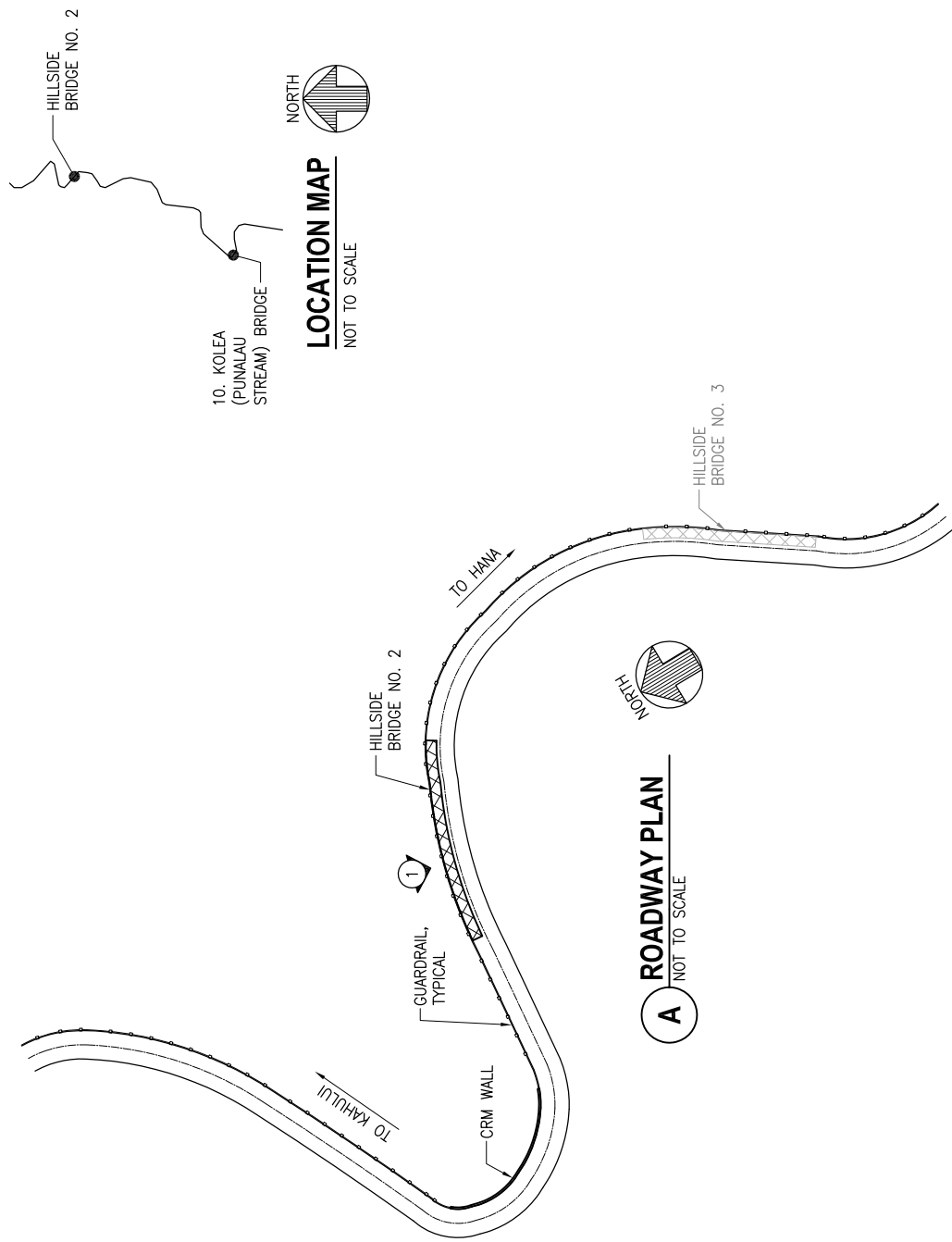
NOT TO SCALE

HILLSIDE BRIDGE NO. 1 (MP 11.40)

Structure Number: 009003600501140

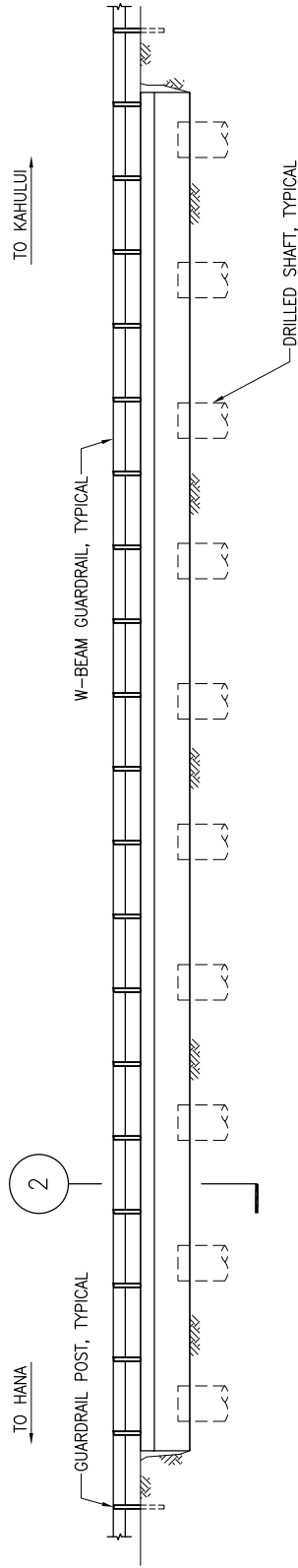
Drawing E 1-2

2015



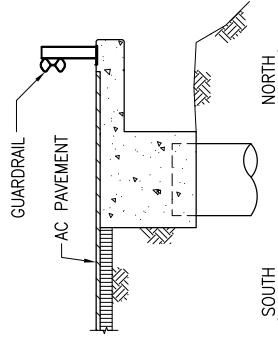
HILLSIDE BRIDGE NO. 2 (MP 12.80)  
 Structure Number: 009003600501280

Drawing E 2-1  
 2015



**1 NORTH ELEVATION**

NOT TO SCALE



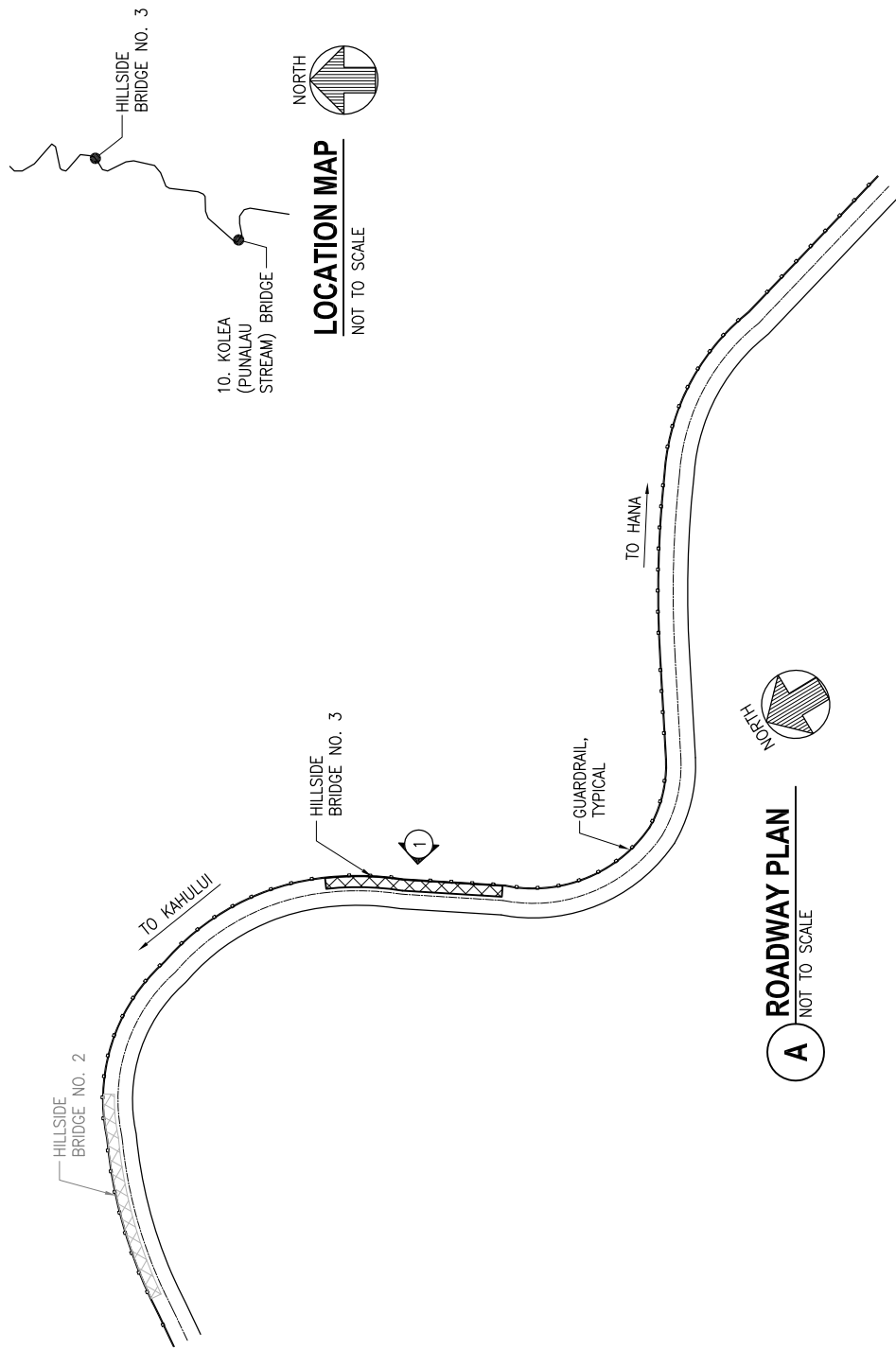
**2 SECTION TYPICAL**

NOT TO SCALE

HILLSIDE BRIDGE NO. 2 (MP 12.80)  
Structure Number: 009003600501280

Drawing E 2-2

2015



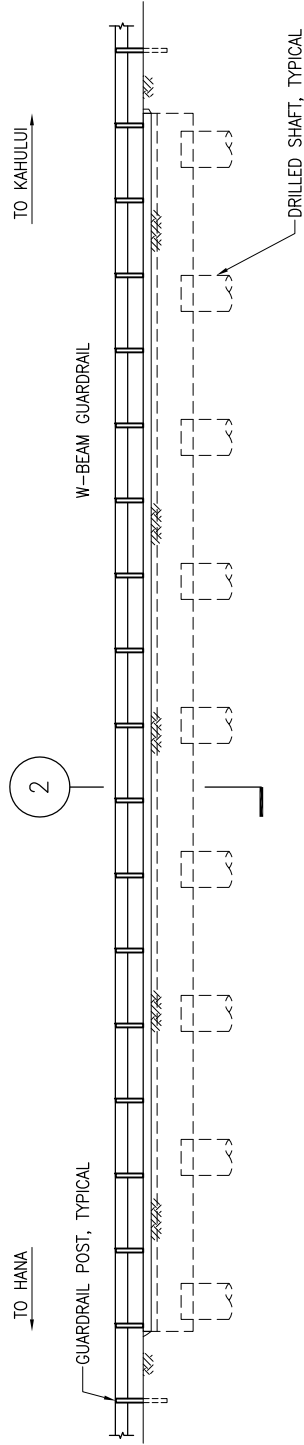
**A** ROADWAY PLAN  
NOT TO SCALE

**LOCATION MAP**  
NOT TO SCALE

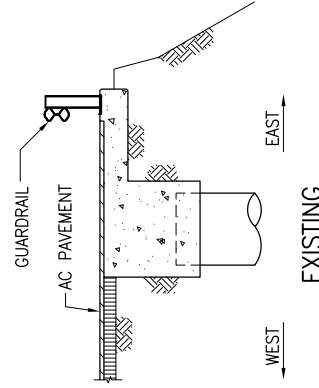
HILLSIDE BRIDGE NO. 3 (MP 12.83)  
Structure Number: 009003600501283

Drawing E 3-1  
2015





**1 EAST ELEVATION**  
NOT TO SCALE

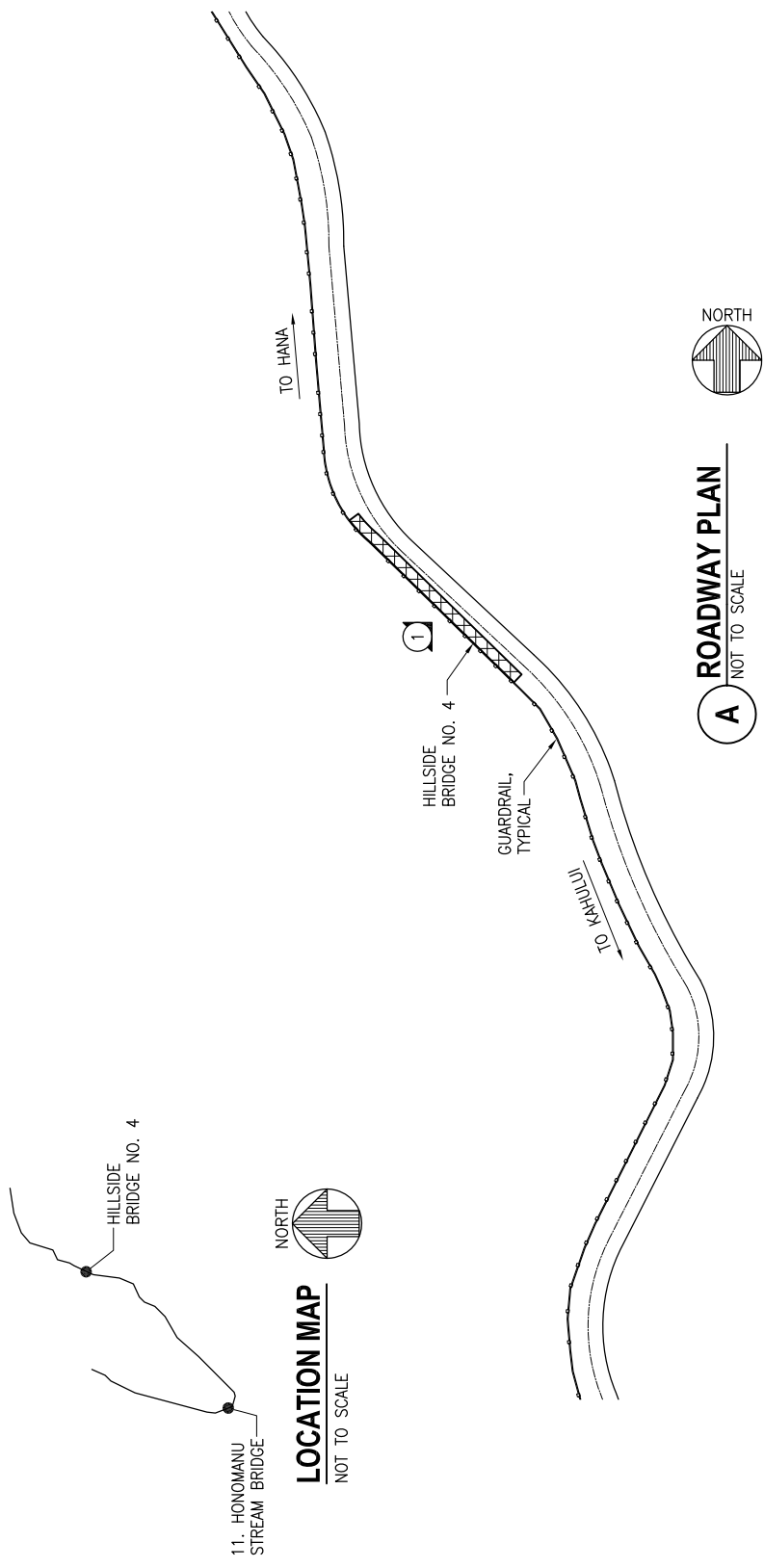


**2 SECTION TYPICAL**  
NOT TO SCALE

HILLSIDE BRIDGE NO. 3 (MP 12.83)  
Structure Number: 009003600501283

Drawing E 3-2

2015



HILLSIDE BRIDGE NO. 4 (MP 14.30)  
 Structure Number: 009003600501430

Drawing E 4-1  
 2015

TO HANA

2

TO KAHULUI

GUARDRAIL POST, TYPICAL

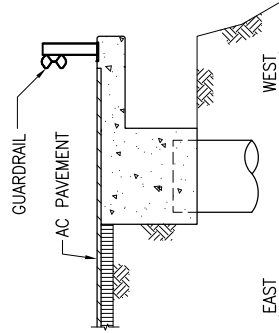
W-BEAM GUARDRAIL

DRILLED SHAFT, TYPICAL

**WEST ELEVATION**

1

NOT TO SCALE



**SECTION TYPICAL**

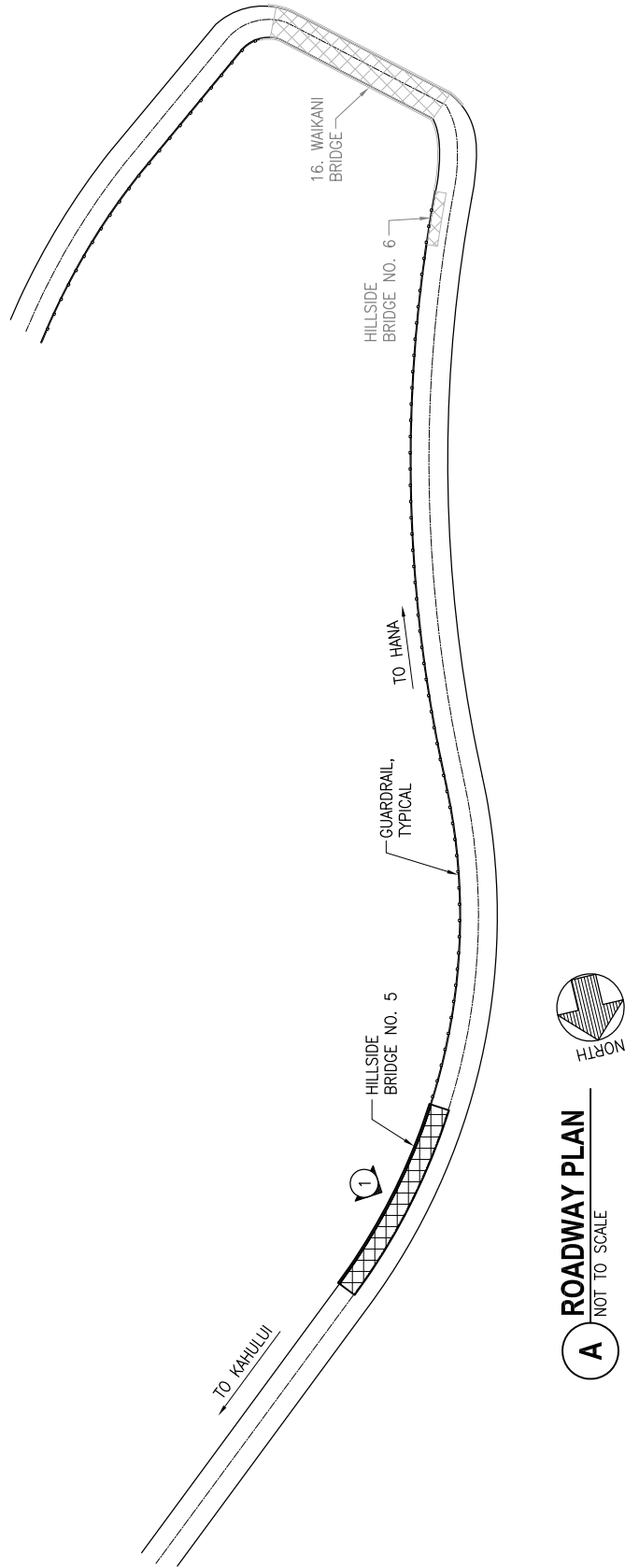
2

NOT TO SCALE

HILLSIDE BRIDGE NO. 4 (MP 14.30)  
Structure Number: 009003600501430

Drawing E 4-2

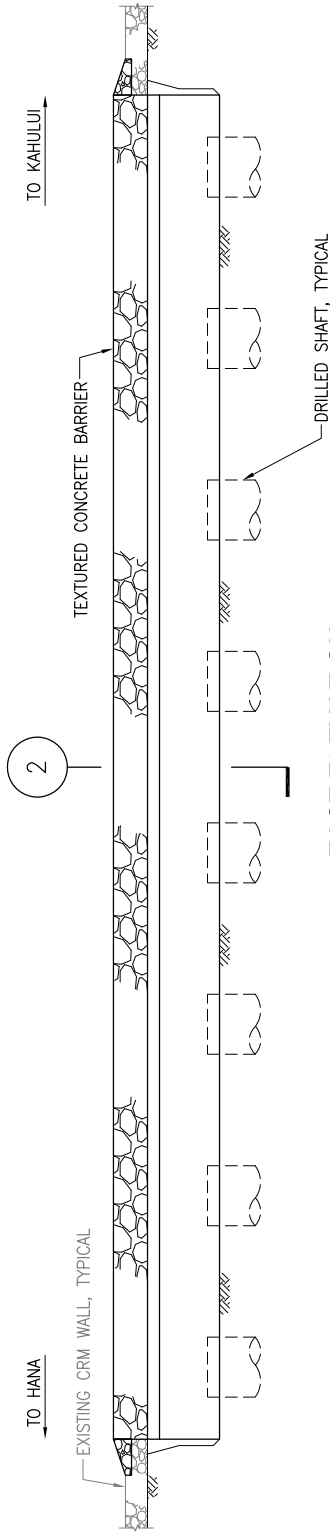
2015



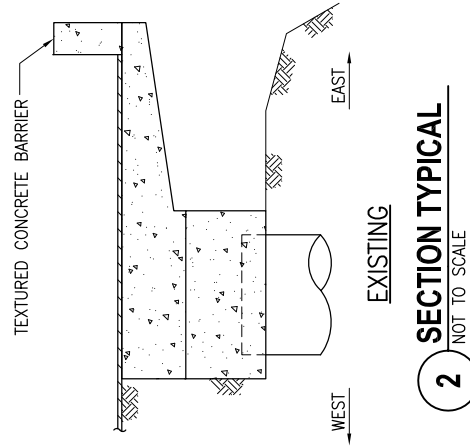
HILLSIDE BRIDGE NO. 5 (MP 19.10)  
Structure Number: 009003600501910

Drawing E 5-1

2015



**1 EAST ELEVATION**  
NOT TO SCALE

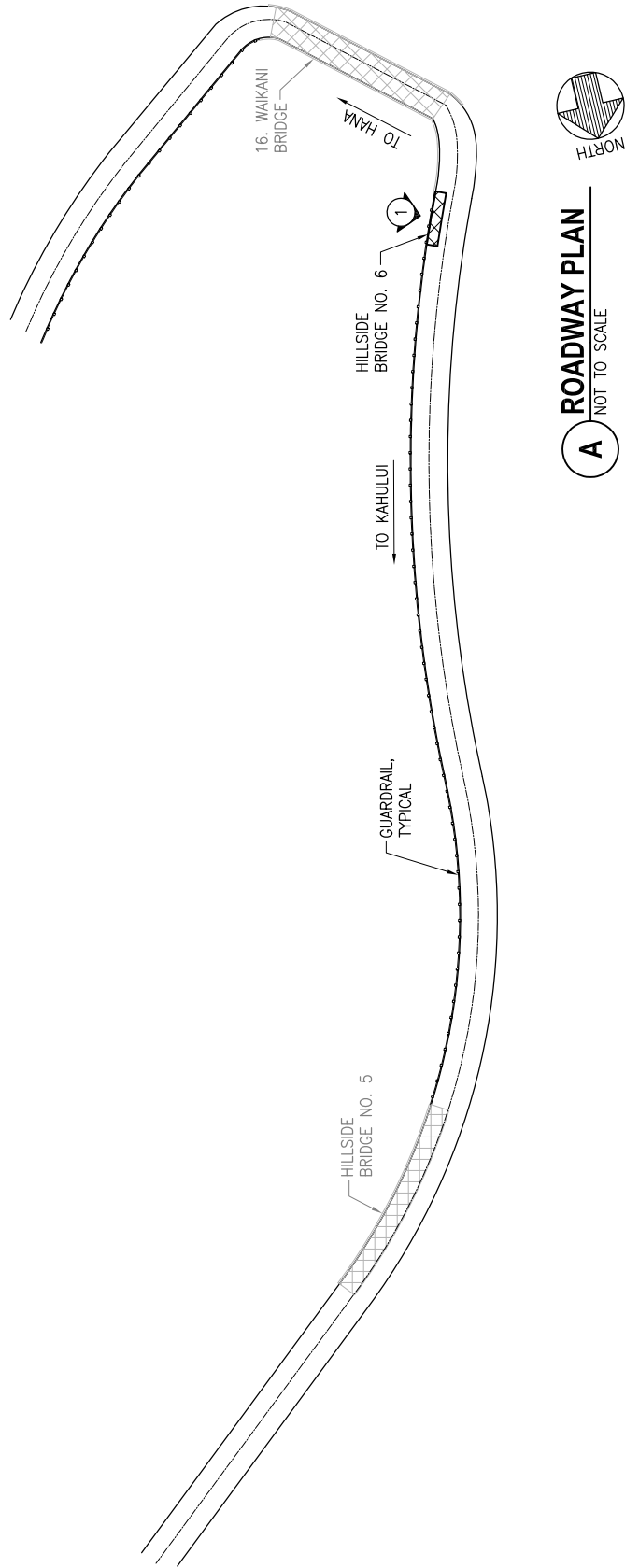


HILLSIDE BRIDGE NO. 5 (MP 19.10)  
Structure Number: 009003600501910

Drawing E 5-2

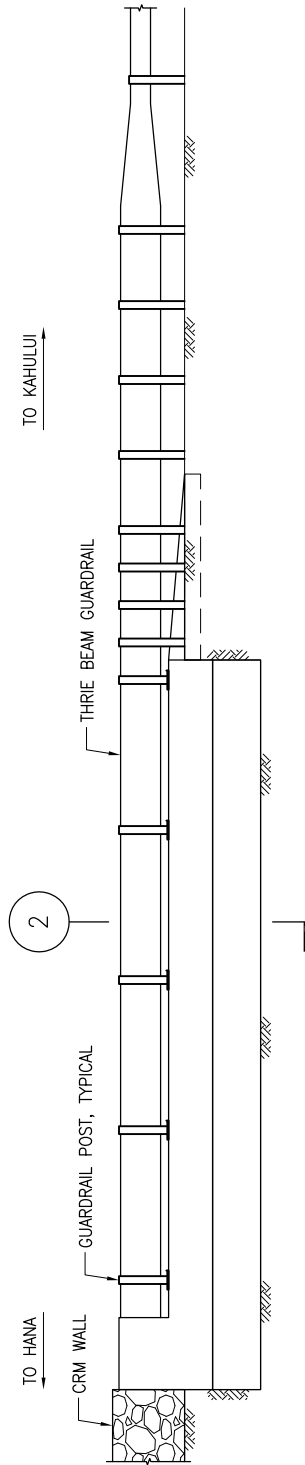
2015



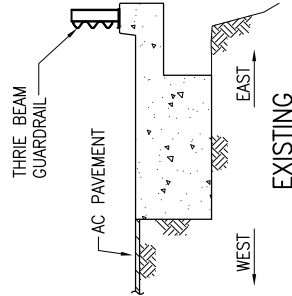


HILLSIDE BRIDGE NO. 6 (MP 19.20)  
Structure Number: 009003600501920

Drawing E 6-1  
2015



**1 EAST ELEVATION**  
NOT TO SCALE

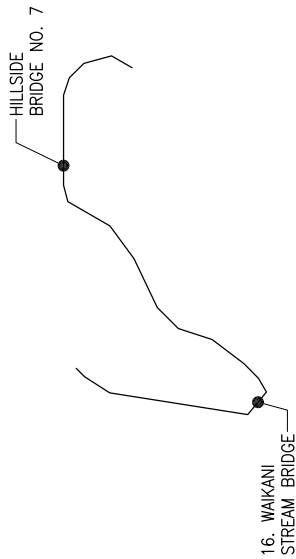


**2 SECTION TYPICAL**  
NOT TO SCALE

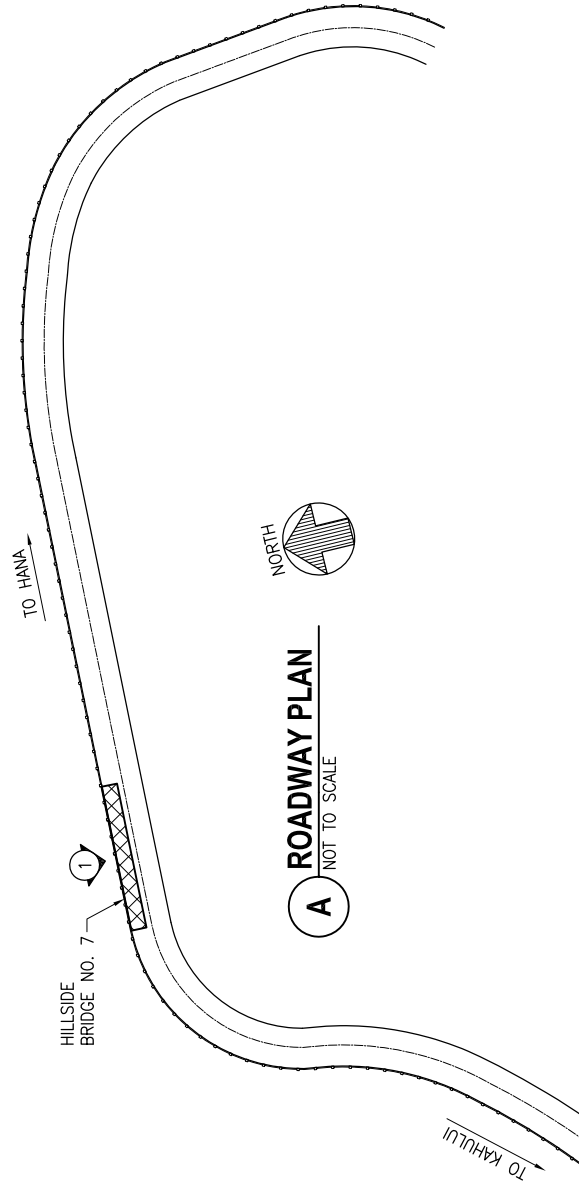
HILLSIDE BRIDGE NO. 6 (MP 19.20)  
Structure Number: 009003600501920

Drawing E 6-2

2015



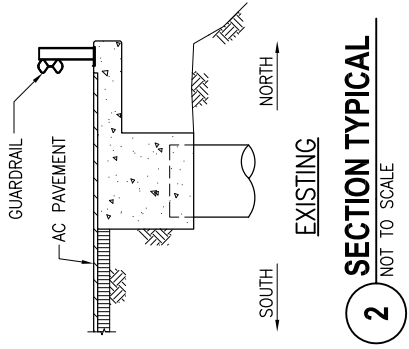
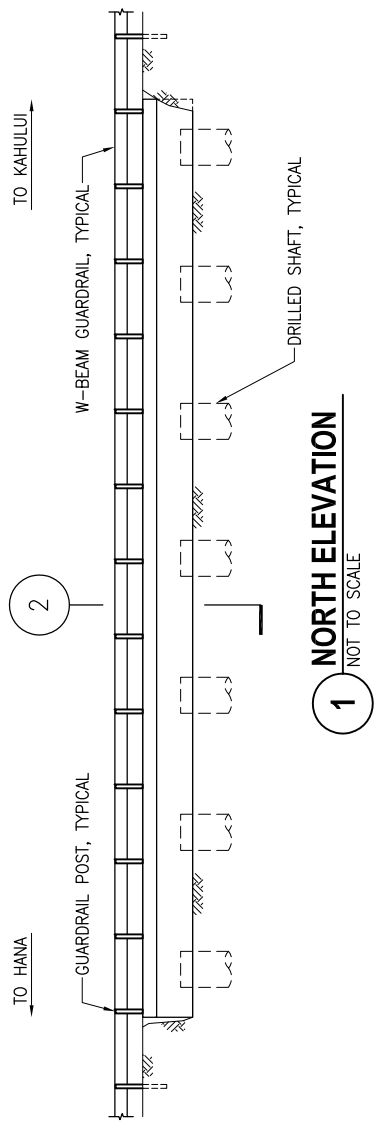
**LOCATION MAP**  
NOT TO SCALE



**A** **ROADWAY PLAN**  
NOT TO SCALE

**HILLSIDE BRIDGE NO. 7 (MP 19.80)**  
Structure Number: 009003600501980

Drawing E 7-1  
2015



HILLSIDE BRIDGE NO. 7 (MP 19.80)  
Structure Number: 009003600501980

Drawing E 7-2

2015

# **SECTION F**

## **SUMMARY & CONCLUSION**





## SUMMARY & CONCLUSION

The Hana Belt Road Historic District, defined by the curvature of the road and outlined by its right-of-way, is a serene and picturesque escape that exemplifies Hawaii's early development and progress in connecting less accessible, rural locations to larger town hubs. Today, the well-traversed state-owned portion of the historic belt road known as the Hana Highway, Route 360, is a scenic journey and a world-wide destination in itself for tourists.

The Hana Highway, Route 360 also primarily serves local residents and commuters, who navigate the road and its weather-related hazards on a daily basis. The team engaged with numerous long-term community stakeholders and representatives, many of whom expressed a desire to retain the historic character and rural nature of the road and important bridge linkages, while acknowledging the need for safety improvements.

Due to changes in vehicular safety code requirements since the early 20<sup>th</sup> century when these structures were built, individual material conditions as these structures have aged, and increased traffic conditions along this particular road, many of the historic bridges and culverts along the Hana Highway, Route 360 require additional treatment beyond simply routine maintenance. As with any historic structure, there are several challenges to maintaining the historic character of each bridge and culvert identified in the *Hana Highway Historic Bridge Preservation Plan* (2015), while ensuring that upgrades for each structure meet current safety codes.

The greatest challenge the team encountered was meeting the safety requirement of providing crash-tested railings at each bridge. Unfortunately, the existing railings, which are considered character-defining features, could not be crash-tested *in situ* without damage. This almost guaranteed the removal of each bridge's key character defining feature.

Fortunately, however, once measured, many of the bridges were wider than the required curb-to-curb width allowable for the number of vehicles on the bridge at any given time. Subsequently, the team was able to identify instances where appropriate crash-tested railings can be placed on the interior side of the historic bridge railings/parapets, and the existing historic railings/parapets can be rehabilitated without complete removal.

Other challenges included addressing unreinforced structural elements such as existing abutments and wingwalls, and the existing geometry of approaches to each bridge or culvert. The team sought to provide creative solutions, looking to precedents from former preservation plans to meet these safety requirements while maintaining the historic character of the road.

This report has been subject to public comment the entire duration of its development, and proposed treatments have been presented to and generally accepted by the community and historic preservation regulators. Therefore, it is highly recommended that HDOT seek a PA with the SHPD, the ACHP, and the various preservation partners that were involved in this project, so that this report may be put into effect as a basis for future treatment of the historic bridges and culverts along the Hana Highway, Route 360. It is recommended that the PA be developed within one year, while the community is familiar with the *Hana Highway Historic Bridge Preservation Plan* (2015).

