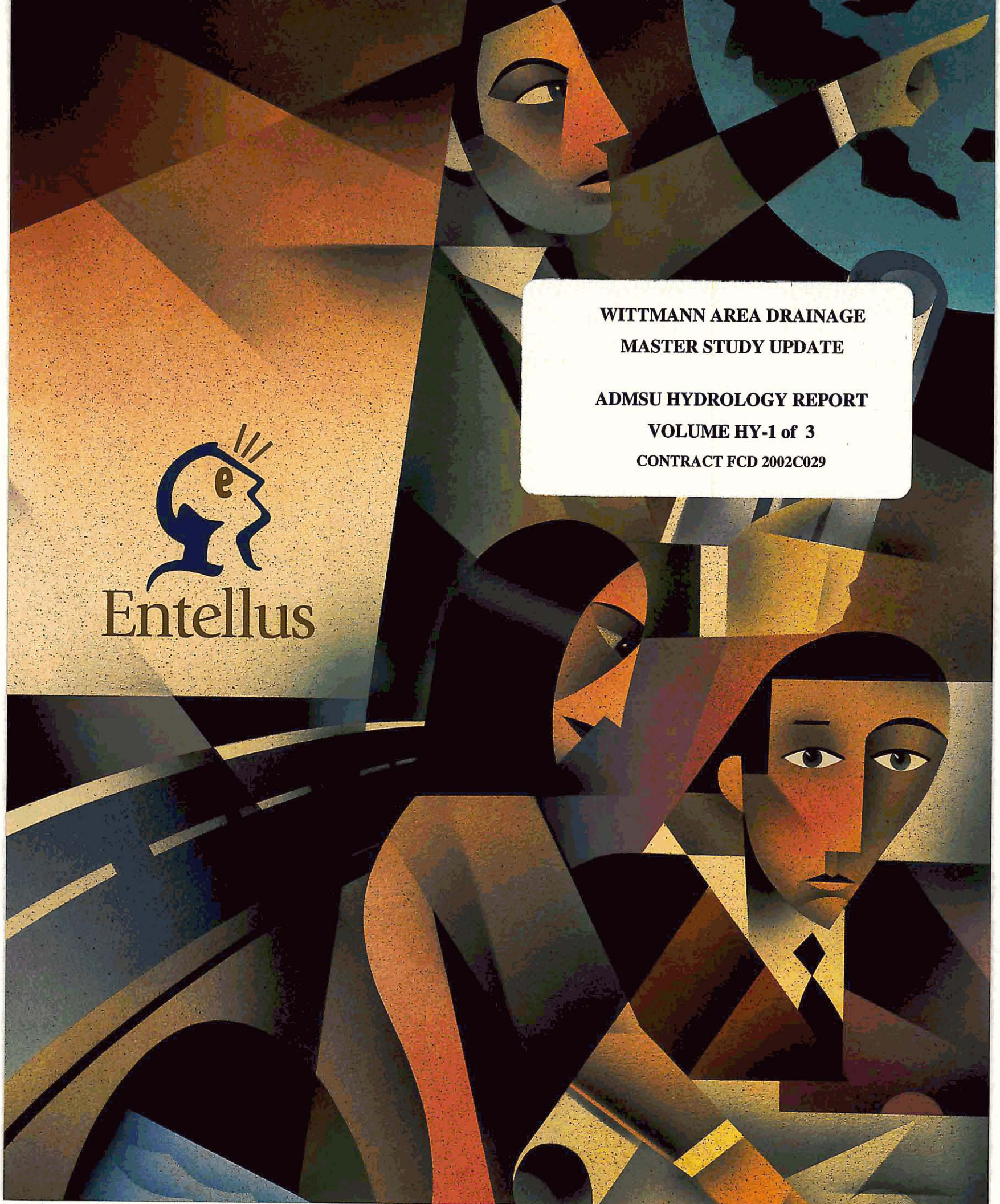

WITTMANN AREA DRAINAGE MASTER STUDY UPDATE

ADMSU HYDROLOGY REPORT

VOLUME HY-1 of 3

CONTRACT FCD 2002C029

Entellus

Flood Control District of Maricopa County

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An **Addendum** for the Wittmann Area Drainage Master Study Update dated **June 2005** includes revisions to the HEC-1 models and other data contained in this volume of the Technical Data Notebook, Volume Hydrology. Without the Volume HY: Addendum, the Wittmann ADMSU Hydrology Report is incomplete.

WITTMANN AREA DRAINAGE MASTER STUDY UPDATE

CONTRACT 2002C029

VOLUME NAME	VOLUME ID
EXISTING CONDITIONS ANALYSIS (PART 1)	EC
ADMSU HYDROLOGY	HY
MCMICKEN DAM HYDROLOGY	MD
FLOODPLAIN DELINEATION	HD
ALTERNATIVES IDENTIFICATION	AI
ALTERNATIVE ANALYSIS MCMICKEN DAM	MA
RULES OF DEVELOPMENT	RD
REPORT OF SURVEY	SR
GEOMORPHOLOGY REPORT	GR
SUBSIDENCE REPORT	SU
ADMINISTRATIVE REPORT	AR

Note: Volume ID will be used for Section, Plate, Figure, and Table Identifiers.

Flood Control District of Maricopa County

WITTMANN AREA DRAINAGE MASTER STUDY UPDATE

TECHNICAL DATA NOTEBOOK

ADMSU HYDROLOGY

VOLUME HY-1 of 3

Contract FCD 2002C029

July 2004

Revised October 2004

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WITTMANN AREA DRAINAGE MASTER STUDY UPDATE
FCD 2002C029

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WITTMANN AREA DRAINAGE MASTER STUDY UPDATE
TECHNICAL DATA NOTEBOOK
ADMSU HYDROLOGY - VOLUME HY

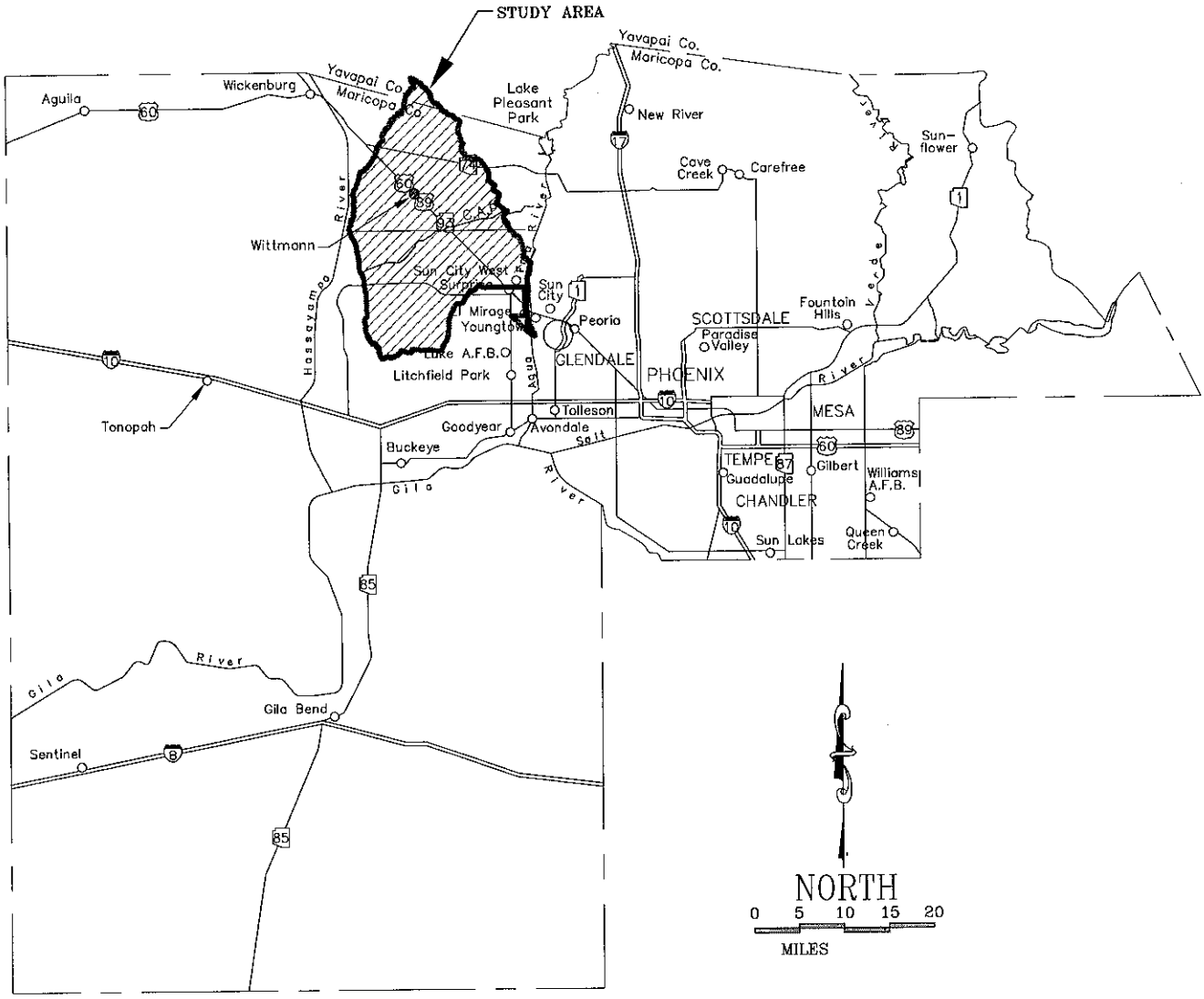
SECTION HY-1: INTRODUCTION

The information and analyses presented in this hydrology report are part of the scope of work performed by Entellus, Inc. for the Flood Control District of Maricopa County (District) as part of the Wittmann Area Drainage Master Study Update under Contract FCD No. 2002C029. The purpose of this report is to present the results of the Hydrology Analysis. In addition, it documents the methodology, assumptions, problems and solutions encountered during the development of the hydrology models.

1.1 Project Location

The study area is located in north-central Maricopa County and is bounded by the Hieroglyphic Mountains to the north and northeast, the White Tank Mountains and McMicken Dam and its outlet channel to the south, the Agua Fria River to the east, and the Hassayampa River basin to the west (**Figure HY-1.1**). The total watershed area is approximately 320 square miles. The study area consists of mostly undeveloped land. However, several small communities exist, and several developments are either under construction, or in the planning stage. The unincorporated towns of Wittmann and Circle City are located along US Highway 60 (US 60) in the center of the study area. The Cities of Surprise, Peoria and the Town of Buckeye have annexed portions of the study area, although most of the area remains undeveloped, or low-density scattered rural residential lands in unincorporated Maricopa County.

The watershed contains several major natural watercourses, mainly: Wittmann Wash, Trilby Wash, Iona Wash, Padelford Wash, and Picacho Wash. Additionally, several man-made features traverse the watershed and cross the natural channels including the Central Arizona Project (CAP) Canal, Sun Valley Parkway, US 60, State Route 74 (SR 74), and Burlington Northern & Santa Fe (BNSF) Railroad. Other significant structures include the McMicken Dam and outlet channel, Bonita Dam,



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VICINTY MAP
FIGURE HY-1.1

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and the Beardsley Canal. The study area has been divided into eight major sub-watersheds as shown in **Figure HY-1.2**.

1.2 Hydrologic Methodology and Results

The hydrologic analysis was performed using the US Army Corps of Engineer's HEC-1 Flood Hydrograph Package. The precipitation runoff model was developed following the procedures and parameters recommended in the District's *Drainage Design Manual for Maricopa County, Volume I, Hydrology (Hydrology Manual)* **(Reference 15)**. The soil losses were estimated using the Green & Ampt method and the Clark Unit hydrograph and S-graphs were used to route excess runoff within the subbasins to their concentration points.

The peak runoff has increased significantly compared to the flows developed during the original Wittmann Area Drainage Master Study (**Reference 40**). These differences can be explained partially by the increase in development in the area, but mostly by the change in methodology used for the current study in accordance with the *Hydrology Manual*. The results of this study compare well with county-wide stream gage data and appear to be reasonable.

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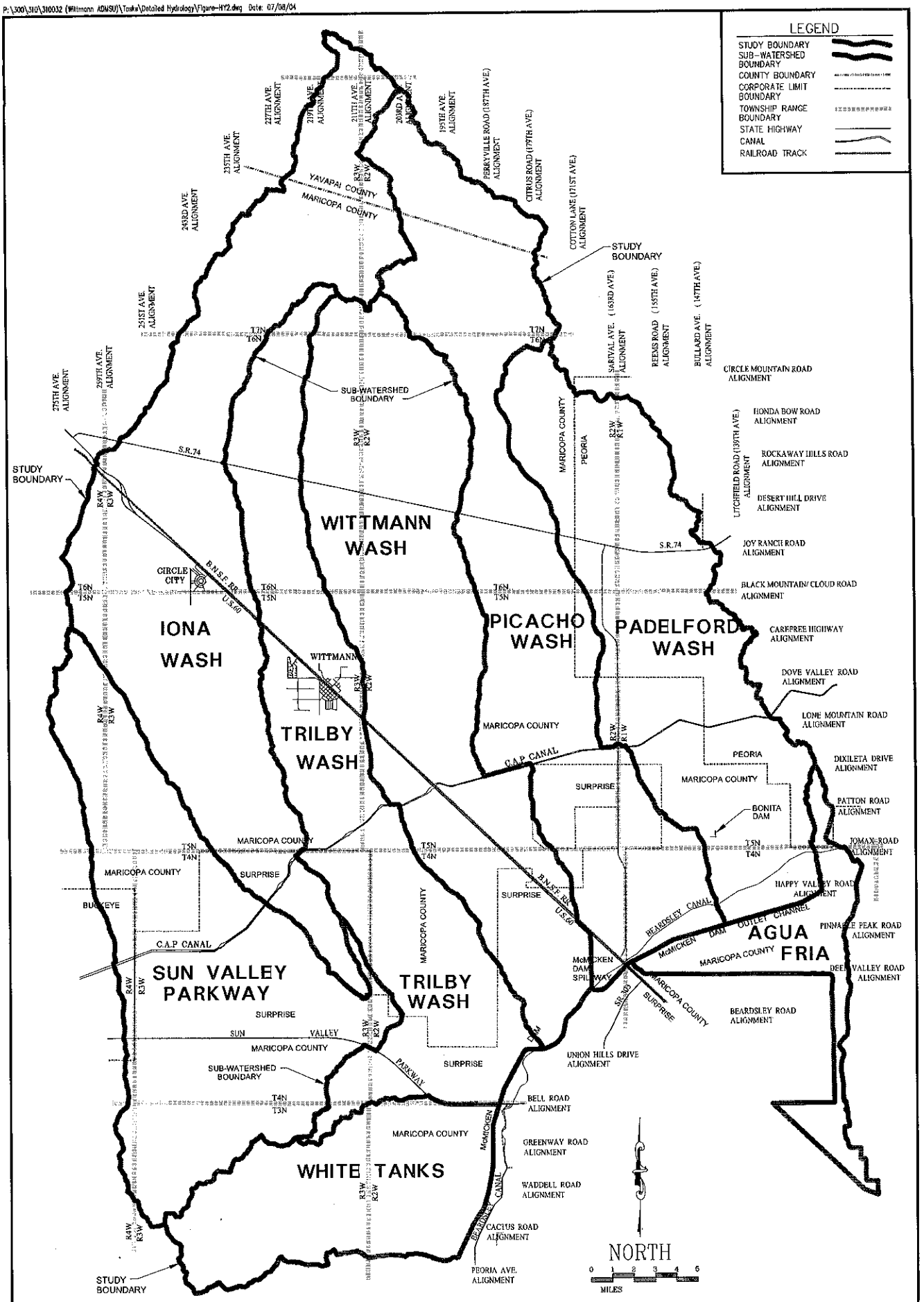

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SUB-WATERSHED
FIGURE HY-1.2

SECTION HY-2: ADWR/FEMA FORMS

The contents of this section are located in: *Volume HD – Floodplain Delineation* **(Section 5, Hydraulics)** of the "*Wittmann Area Drainage Master Study Update Report.*"

SECTION HY-3: MAPPING AND SURVEY INFORMATION

3.1 Mapping

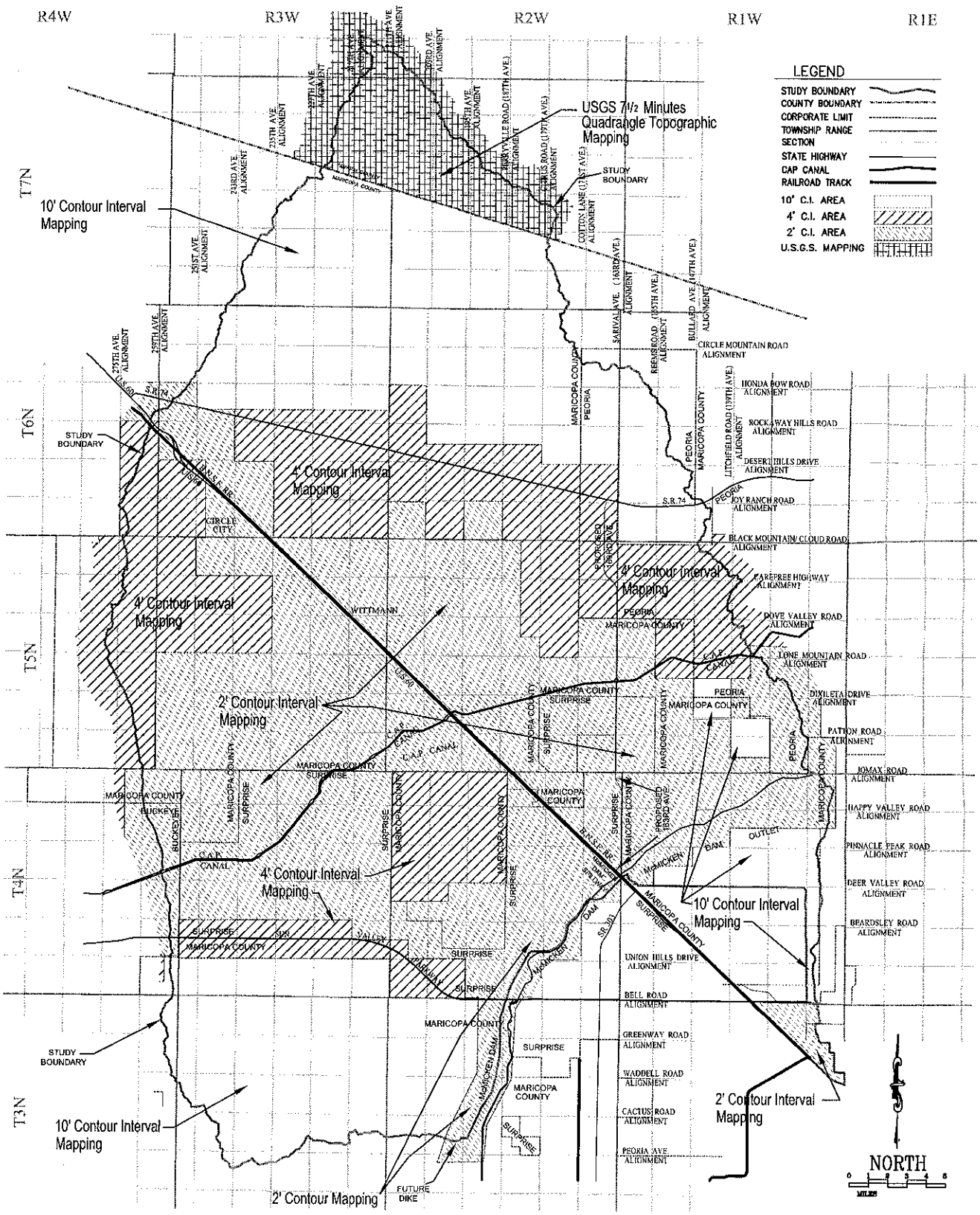
The base map used for this study was furnished by the District based on four different sources:

- USGS 7.5 minute quadrangle topographic mapping (**Reference 1**)
- 400-scale, 10-foot contour mapping (**Reference 2**)
- 200 scale, 4-foot contour mapping (**Reference 3**)
- 100 scale, 2-foot contour mapping (**Reference 4**)

Figure HY-3.1 shows the location of each type of mapping used. All other mapping other than the USGS mapping was prepared by Landata, Inc. for the District under separate contract. The vertical control was based on the North American Vertical Datum of 1988 (NAVD-88), and horizontal control was based on State Plane Coordinate System Arizona Central (1983 NAD). The District provided Entellus with a composite ASCII grid file developed from all four of these mapping sources.

3.1.1 Watershed Map

Watershed boundaries and hydrologic parameters were determined primarily from the topographic base map furnished by the District. Aerial photography and field observations were also used to determine basin boundaries. **Plate HY-6** contains a plot of the general topography of the area based on the best topographic mapping available, which include USGS 10-foot contour interval (C.I.), 4-foot C.I., and 2-foot C.I. mapping (**Reference 1-4**). For the areas where 2- and 4-foot C.I. mapping was available, only the index contours were plotted.



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MAPPING COVERAGES

FIGURE HY-3.1

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3.1.2 Soils Map

Electronic soils maps were furnished by the District's GIS Department for the portion of the watershed within Maricopa County. This mapping is a digital version of the Natural Resources Conservation Service (NRCS, formerly SCS) *Soil Survey of Maricopa County, Arizona-Central Part* (**Reference 5**) and *Soil Survey of Aguila-Carefree Area* (**Reference 6**). For the area outside of Maricopa County, the soils information was digitized from the *Soil Survey of Yavapai County, Arizona, Western Part* (**Reference 7**). **Plate HY-5** contains the soils data provided by the District.

3.1.3 Land Use Map (Existing Conditions)

Existing land use information was created from the 2002 aerial photos provided by the District (**Reference 8**) and the County Assessor's maps (**Reference 9**). The existing land use types are presented in **Plate HY-3.**

3.1.4 Land Use Map (Ultimate Development)

Future condition land use information was provided by the District's GIS Department and corresponds to the Maricopa Association of Governments' (MAG) General Plan. Entellus cross-referenced MAG's general plan with the general plans for the Cities of Surprise and Peoria due to the fact that each plan has different nomenclature for land use types. For the most part, the plans are in close agreement. However, there were some small areas with differences in development density in the City of Surprise. The future land use map (MAG's General Plan) was modified to include the land uses shown in the City of Surprise's Land Use Plan. Comparisons between the two plans are included in **Appendix D.2.2.**

The differences between the MAG General Plan and City of Peoria's plan were considered insignificant. Peoria's plan included three land uses that had a range of dwelling units per acre that overlapped MAG's ranges. The future land use is presented in **Plate HY-4**.

A small portion of the western edge of the Sun Valley sub-watershed falls within the Town of Buckeye. The land use category in this small portion is Rural Residential with undefined dwelling unit density; therefore, MAG's designation was used.

3.2 Survey Information

Entellus has not performed any new field survey for the hydrology analysis. Survey data, prepared for the District by DTM Inc., were provided to Entellus, Inc. in the following four Structure Survey Reports:

Wittmann ADMP State Route 74 Structure Surveys (**Reference 10**)
Wittmann ADMP Highway 60-Railroad Structure Surveys (**Reference 11**)
Wittmann ADMP Sun Valley Parkway Structure Surveys (**Reference 12**)
Wittmann ADMP CAP Canal Structure Surveys (**Reference 13**)

SECTION HY-4: HYDROLOGY

4.1 Method Description

The U.S. Army Corps of Engineers' HEC-1 Flood Hydrograph Package, hydrologic rainfall/runoff computer program, Version 4.1, was used to generate peak flows in this study area. Input parameters for the hydrologic modeling were developed using the 2003 version of the Watershed Modeling System (WMS) 7.0 software developed by Brigham Young University (**Reference 14**). The procedures and model parameters were based on the *Drainage Design Manual for Maricopa County – Volume 1 – Hydrology Revised 1997* (hereinafter referred to as the *Hydrology Manual*) (**Reference 15**). The following hydrologic models were prepared:

- 100-yr, 24-hr Existing
- 100-yr, 6-hr Existing
- 100-yr, 24-hr Future (ultimate development)
- 100-yr, 6-hr Future (ultimate development)

The models were developed using Green and Ampt methodology to estimate the rainfall losses. Excess rainfall was collected at concentration points using the Clark Unit Hydrograph methodology. The flows were then routed downstream using the normal depth channel routing option of HEC-1. Ponding and storage was modeled using the level pool reservoir routing. S-Graphs were used for the two basins above Bonita Dam per direction from the District. This was done to match a prior study prepared by others for the analysis of the breaching of this dam **(Reference 39).**

The flow routing schematic for runoff modeling is presented in **Plates HY-1 (sheets A-D)**. The 24-hour existing condition model was used as the base model for this study. For large watersheds, the 24-hour duration storm produces higher peak flows and runoff volumes than

lesser duration storms. However, the 6-hour duration storm was also modeled because for smaller subbasins at intermediate concentration points, the 6-hour storm may generate higher peak flows. The final results of the study include the larger of the peak flows generated by the two storm durations at intermediate concentration points.

4.2 Parameter Estimation

4.2.1 Drainage Area Boundary

Based on the topographic mapping information and watershed characteristics, the watershed was divided into major sub-watersheds as shown in **Figure HY-1.2**. The majority of the study area drains into McMicken Dam. The watershed contributing to the dam is approximately 220 square miles. An additional 90 square miles drains into the McMicken Outlet Channel and McMicken Outlet Wash for a total of approximately 310 square miles. An additional seven square miles contribute runoff to McMicken Outlet Wash downstream of the McMicken Outlet Channel confluence. For clarity the watershed was divided into eight sub-watersheds.

- White Tank Mountains sub-watershed (WT1)
- Sun Valley Parkway sub-watershed (SV2)
- Iona Wash sub-watershed (IW3)
- Trilby Wash sub-watershed (TW4)
- Wittmann Wash sub-watershed (WI5)
- Picacho Wash sub-watershed (PI6)
- Padelford Wash sub-watershed (PD7)
- Agua Fria River sub-watershed (AF8)

Each of the sub-watersheds was further divided into subbasins. Concentration points were created at strategic places such as the natural confluence of tributaries and at split flow locations, and where manmade drainage facilities or structures appeared

likely to affect runoff characteristics. Concentration points were also located at existing developments that have been or could possibly be impacted by flooding.

The US 60, SR 74, Sun Valley Parkway, and the BNSF Railroad affect the movement of runoff throughout the study area watershed. There are more than 300 culverts along these major transportation facilities. In this study, only those culverts that were deemed to have a significant impact on runoff were modeled. For example, concentration points were only created at culverts with significant storage at the structure to attenuate runoff or where runoff might be diverted to an adjacent subbasin that is tributary to a different downstream concentration point. An additional consideration is that roads and drainage facilities appear to be fairly new and are not likely to be modified or replaced for the foreseeable future. Therefore, discharge values at newer culvert locations would not be needed for future drainage infrastructure planning purposes.

The most significant man-made facility affecting runoff within the study area other than McMicken Dam is the CAP Canal. The CAP Canal has a high embankment on the north (upstream) side to protect it from flooding. This embankment provides a large impoundment area upstream with the potential of storing a significant volume of flow. Flows intercepted by the canal are then routed to 22 different overchutes of various sizes and types that discharge to the downstream side of the canal. The CAP Canal has a significant effect on the watershed response, cutting off historic flows in many areas and concentrating runoff in channels downstream of the overchute locations. Subbasin boundaries were placed along the canal alignment in order to model the effect of the storage and the routing of flow through the structures.

There are two other structures of some significance located within the study area that also affect runoff, Lake Bonita Dam and the Beardsley Canal. Lake Bonita Dam has been classified by ADWR as an unsafe dam. According to ADWR, this dam cannot withstand a significant runoff event without failing. ADWR is currently developing a

plan to permanently breach the dam, and it expects the work to be completed within the next few years. This is an ADWR project currently under design with technical assistance from the District. We have been directed by the District to include a concentration point at the location of the dam, but not to model the dam itself. This is in anticipation of it being removed in the near future. Therefore, the results of the hydrologic analysis assume that the dam has been removed and flows are allowed to pass through the impoundment area freely.

The Beardsley Canal has four-cross drainage structures within the study area; however, the canal does not appear to have adequate storage or a collection system on the upstream side to prevent it from being overtopped during a severe runoff event. Aerial photos appear to confirm that the canal has been overtopped in the past. Storage was modeled along the upstream side of the Beardsley Canal, although it is not as significant as the storage behind the CAP Canal. Basin boundaries reflect the impoundment areas and locations of the overchutes along the canal.

There are other minor facilities/structures such as small diversion ditches or dikes and small culverts at numerous locations throughout the watershed. However, most of these structures are small, old, not maintained, do not appear to meet current design standards, and/or appear to be intended for only minor runoff events. Therefore, these features were generally ignored and basin boundaries do not reflect their presence.

4.2.2 Watershed Work Maps

The work maps for this study are essentially all the various GIS layers and mapping provided by the District, as described earlier in this report under **Section HY-3**.

The parameters used in the models and the basin and routing information are depicted in **Plates HY-1** through **HY-8.** Eight sub-watersheds were identified and named after the main wash or a prominent feature in the area as shown in **Figure HY-1.2**. The subbasins were named with five to six alphanumeric characters. The first three

characters identify the sub-watershed where the subbasin is located (See **Section 4.2.1** for abbreviation), and the remaining characters are numeric values usually starting at the downstream end of the sub-watershed and increasing in the upstream direction. The subbasin identifier is preceded by a letter that represents the type of operation being performed.

R	Route
C	Concentration Point
D	Diversion
S	Storage Route

For example, CWI505 is a concentration point of subbasin WI505 in the Wittmann sub-watershed.

Plates HY-1 (sheets A-D) show the schematic diagram of the hydrologic model. It is noted that portions of the Padelford sub-watershed are not included in these plates. This area was recently studied separately as part of the *Padelford Wash Floodplain Delineation Study* (**Reference 26**), and its results were incorporated in this analysis. A copy of the P*adelford Wash Floodplain Delineation Study* schematic map was reproduced and included in this report as **Plate HY-1E**. **Plate HY-2** shows the time of concentration paths, routed paths and concentration point locations. **Plates HY-3** through **HY-5** shows the distribution of soils and the existing and future land uses. **Plate HY-6** shows the topographic information used for this study, and **Plates HY-7** and **HY-8** show the generalized hydraulic parameters used to determine routing reach response to runoff.

4.2.3 Gage Data

There are five stage gages in the study area. The first gage is located at the McMicken Dam Principal Spillway, near the US 60 and 163rd Avenue. This gage has data from the last 20 years. The second gage location is on the bank of the McMicken Floodway (Outlet Channel), just downstream of the first gage. This gage has data from the last ten years. The third gage is located in the Ford Canyon Wash, in the White Tank Mountain Regional Park, one-quarter mile north of Ford Canyon

Road. This gage has records for the last two years. The fourth gage is located on the east slope of the White Tank Mountains, and this gage has data for the past fifteen years. The last gage location is in the Upper Trilby Wash, two miles upstream of Castle Hot Springs Road. This gage has records from the last three years. These gages were not used specifically in this project, but some of the gage data are incorporated in the *Flood Frequency Analysis of Stream Flow Stations* (**Reference 17),** which was used in the verification of the results from this model as discussed in **Section 4.6**. The gages at the McMicken Dam Spillway and the McMicken outlet Channel are the only gages in the study area that have a long enough period of record to be useful for calibration. Gage data for the McMicken Outlet Channel and the McMicken Dam Spillway were obtained from the District's website and are included in **Appendix D.1.3.**

There are 13 precipitation gages scattered throughout the study area. However, the majority of these gages have less than four years of record and their usefulness in calibrating the model is limited.

4.2.4 Statistical Parameters

Precipitation/runoff models were developed to evaluate the hydrologic response of the study area. New statistical data were not developed as part of this study. However, results of the runoff models were compared with gage data collected by the District for the entire County, which is located in *Flood Frequency Analysis of Stream Flow Stations* (**Reference 17).** The results appear to be within the range of expectation for this type of terrain. Also, the results were compared with the results from regional regression equations. These comparisons are presented later in **Section HY-4.6**.

The stage gages located at the McMicken Dam and at the McMicken Outlet Channel have long enough periods of record to obtain meaningful stream data statistical analysis using the Log-Pearson Type III analysis as described in *Bulletin 17B - Guidelines for Determining Flood Flow Frequency* (**Reference 41**). However, both

of these gages measure flows that have been significantly affected by the storage in McMicken Dam and the procedures specified in *Bulletin 17B* are not applicable to watersheds with significant storage.

4.2.5 Precipitation

4.2.5.1 100-year, 24-hour Rainfall Estimation

Precipitation totals for the 100-year, 24-hour event were obtained from the isopluvial maps contained in the *NOAA Atlas 2 Precipitation Frequency Atlas of the Western United States – Volume VIII Arizona* (**Reference 18**), hereafter referred to as *NOAA Atlas 2*, and selected isopluvial maps for Maricopa County located in the *Hydrology Manual*. The SCS Type II 24-hour precipitation distribution was used as encoded in the WMS software. Areal reduction was performed using the JD record option of HEC-1 and based on the curves provided in the *Hydrology Manual*.

4.2.5.2 100-Year, 6-Hour Rainfall Estimation

Precipitation totals for the 100-year, 6-hour event were obtained from the isopluvial maps contained in the *NOAA Atlas 2* and selected isopluvial maps for Maricopa County, which are located in the *Hydrology Manual*. The Maricopa County 6-hour local distribution was used, as provided in the *Hydrology Manual*. Areal reduction was performed using the JD record option of HEC-1 and based on the curves provided in the *Hydrology Manual*.

4.2.6 Physical Parameters

4.2.6.1 Basin Parameters

Soils: As previously noted, the District provided soils data within Maricopa County in digital format. The soils map is a digital version of the *Soil Survey of Aguila-Carefree Area* (**Reference 6**) and the *Soil Survey*

of Maricopa County, Arizona-Central Part (**Reference 5**). Soils within Yavapai County were obtained from the *Soil Survey of Yavapai County, Arizona, Western Part* (**Reference 7**).

The District provided the hydraulic conductivity (XKSAT) values for the portion of the watershed within Maricopa County in the form of a GIS database table. The table was appended to include XKSAT values for the soils in Yavapai County. The XKSAT values for soils in Yavapai County were estimated based on the procedure outlined in the *Hydrology Manual.* The procedure and calculations for soils in Yavapai County are included in **Appendix D.2.1**.

Green and Ampt parameters were generated using the WMS software (**Reference 14**) and were automatically estimated from the soil and land use data. During the development of the McMicken Dam hydrologic model performed separately under this contract, several basins were tested using the District's *Drainage Design Menu System* (*DDMS*) program (**Reference 19**) to verify WMS's calculation of these parameters. The Green and Ampt parameters generated from both programs were virtually identical. Details of these comparisons and a summary table of the Green and Ampt parameters used for these basins are documented in **Volume MD** *McMicken Dam Hydrology.*

Land Use: Existing land use was estimated based on the analysis of aerial photography provided by the District (**Reference 8**) and the County Assessor's maps (**Reference 9**). Areas with similar development characteristics were identified, and a land use type designation was assigned based on density and type of development.

Future land use was provided by the District in digital format and reflects the MAG General Plan development. As previously stated, existing land use is generally undeveloped; therefore, there will be a significant difference in land use as the area develops to its ultimate density. Other differences would include improvements to the White Tank Mountain Regional Park that is called for in the General Plan.

There are 38 different MAG land use categories. *Table 4.2a* from The *Hydrology Manual* only lists seven categories. However, the District is in the process of updating its manual, and the *Draft Hydrology Manual* (**Reference 37**) was consulted because it includes additional categories for a total of 17. Based on the values recommended in the *Hydrology Manual* and the *Draft Hydrology Manual*, the land use parameters for all 38 MAG land use categories were assigned. **Appendix D.2.2** includes copies of land use tables from both hydrology manuals and the modified table that summarize the land use classifications and parameters used for this study.

The *Hydrology Manual* recommends adjusting the land use parameters in order to represent typical development within the study area. The parameters were adjusted in four different ways:

- Adjustments to four categories were made to reflect the difference in density based on dwelling units per acre. For example, there is only one LDR (Low Density Residential) category in *Table 4.2* of the *Draft Hydrology Design Manual*. LDR-1 and LDR-2 were created in order to match the MAG land use plan. Because the MAG plan lists different dwelling units per acre, the percent impervious values were adjusted to reflect a value that fell between the next higher and lower density category. Also vegetative cover

was increased from 30% to 50% since the lots are smaller and more likely to be landscaped.

- A 5% impervious value was used for three of the four open space categories because the descriptions included some type of development (parks, golf courses, and undetermined).

- For any developed area with grass, normal saturation conditions were assumed, since the grass requires some watering.

- Adjustments to the percent vegetation cover were made in order to reflect conditions observed in the existing developments within the study area. The adjustments were made for specific use categories, primarily industrial and open space. The values for vegetation cover found in *Table 4.2* of the *Draft Hydrology Manual* and *Table 4.2a* of the *Hydrology Manual* seemed extremely high compared to what has been observed in developed areas within the study area. Most developments within the study area have maintained natural desert or bare ground for their landscaping. In order to reflect these conditions, the percent vegetation cover for the open space categories were adjusted downward. The vegetation cover for undefined and passive Open Space (natural desert) was adjusted down from 90% to 30%. The ground cover was reduced from 90% to 50% for active parks and to 75% for golf courses. For commercial land use, the value was reduced from 75% to 60% because the tendency in the area is towards natural landscaping

The City of Surprise, Town of Buckeye, and City of Peoria all have developed their own general plans, which differ slightly from the MAG general plan. The areas affected by this variation are few, and the

differences in land use slight. Where differences occurred, the land use classifications with the highest density were used. Graphics of various General Plans are in **Appendix D.2.2.**

There are several subbasins where the calculated percent impervious for existing conditions is greater than for future conditions. This is due to the difference in the level of detail between the existing conditions and the future conditions land use information. The existing conditions land use is much more detailed than the MAG land use plan. An example of this difference is at Circle City. For the existing conditions land use it was determined that the area of Circle City was MDR-1: Medium Lot Residential – Single Family (2-4 du per acre) which corresponds to a percent impervious of 30%. The MAG land use plan, as used for the future land use, shows Circle City, as well as a large surrounding area, as being LDR-1: Estate Residential (1/5 to 1 du per acre), which corresponds to a percent impervious of 10%. Thus the percent impervious for the subbasin containing Circle City is greater for the existing conditions than it is for the future conditions. The existing conditions land use is a site specific land use condition, where the future land use is a general plan for the entire area. Some areas within the LDR-1 designation may be more or less dense in the future, but the MAG land use plan for the entire LDR-1 area where Circle City is contained is approximately 1/5 to 1 du per acre.

4.2.6.2 Clark Unit Hydrograph

The Clark unit hydrograph was used to route excess runoff within a subbasin to its concentration point, with the exception of subbasins PD726B and PD740. The area covered by these subbasins was modeled using S-graphs as part of the Lake Bonita Dam breaching project currently under development by ADWR. The results of this analysis are presented in the *Hydrologic Study for Bonita Dam – Maricopa County, Arizona*

(**Reference 39**). Per the District's request, S-graphs were used for these two subbasins for consistency.

4.2.6.3 Time of Concentration

The slope and the hydraulic length of each subbasin were manually estimated based on the topographic mapping and the procedures in the *Hydrology Manual.* For subbasins with a slope greater than 200 ft/mile, an adjusted slope was calculated based on *Figure 5.4* from the *Hydrology Manual.* A copy of this figure can be found in **Appendix D.2.3.**

The subbasin time of concentration and storage coefficient (R-values) were estimated using WMS 7.0 and by following the procedures outlined in the *Hydrology Manual.* The parameters used in the time of concentration calculations and the results are listed in **Table HY-D.2.3** located in **Appendix D.2.3**.

The Resistance coefficient Kb values used to estimate the time of concentrations were estimated using the equation and parameters included in *Table 5.*3 of the *Hydrology Manual.* **Plate HY-7** shows the four different roughness classes used to estimate the Kb value. The same roughness classes were use for both existing and future condition. This was based on the assumption that most of the natural drainage network would be maintained as the area develops. Development usually decreases the Kb value since it tends to channelize the washes. However, there is also an opposite effect occurring because the increased amount of obstructions such as roadway crossings and structures. For this study it was assumed that these two effects of development offset each other and that there is not a significant difference in the resistance coefficient.

The Tc and R values vary with the rainfall intensity and usually need to be recalculated for each storm. The Tc and R values were calculated for both the 24-hour and the 6-hour storms.

The times of concentration were checked for excessively long values (larger than 90 minutes). WMS defaults to 90 minutes when the calculated time of concentration is longer than 90 minutes. Entellus reviewed all subbasins that had this default value. For these subbasins, the time of concentration was manually computed using the procedure outlined in the *Hydrology Manual.* As a result of this review, several subbasins were further subdivided because a time of concentration longer than 90 minutes usually indicates that the subbasin size is too large for the assumptions on which the computational methods are based. Subbasins PD726A, PD736, PD756, PI654 and PI687 in the 24-hour models and PD736, PD756, PI654, PI687 and WI564 for the 6-hour models were the only basins left with a default Tc of 90 minutes. This value is very close to the manually obtained Tc, and it appears that 90 minutes is a good representation of the subbasin conditions. See **Appendix D.2.3** for detailed calculations.

The hydraulic length of subbasins along ponding areas such as the CAP Canal, Beardsley Canal, and McMicken Dam is shown in **Plate HY-2** as the longest path to the concentration point. However, the actual length used to estimate the subbasin slope was adjusted to exclude the portions of this length that parallel the structure within the ponding area. The slope along this portion of the path is either mild or reverse and including it would reduce the average basin slope unrealistically.

Time-area relations were defined for all subbasins. Two time-area relations were utilized: urban and natural. These Time-Area Relations

were taken from the Hydrology Manual. For the existing conditions, aerial maps were examined for large areas of urban development. Any subbasin found containing a significant portion of existing development was deemed urban. The remaining subbasins were natural. For the future conditions models, the future land use map was examined and subbasins that were designated as future development were deemed urban, while open space was considered natural. Subbasins where the majority of the future planned development is residential, with a density of less than 1 dwelling unit per acre, were assigned natural Time-Area Relations. Details are found in **Table HY-D.2.3**.

4.2.6.4 Reach Routing Parameters

The normal depth routing method was used to route flows from one concentration point to the next

NSTEPS: The time steps (NSTEPS) used in the normal depth routing were estimated using an iterative process. The initial values for the NSTEPS were estimated using an assumed wave celerity of 3 to 10 fps, depending on the slope of the reach and using the following equation:

$$NSTEPS = \frac{ReachLength}{Velocity * TimeStep * 60}$$

These initial time steps were entered in the model and the model was run. Then a new set of NSTEPS was estimated based on the difference between the time-to-peak of the inflow and outflow hydrographs using the following equation:

$$NSTEPS = \frac{\Delta Time\,to\,peak}{TimeStep}$$

This process was repeated until the NSTEPS value did not change significantly. Finally, the wave celerity estimated from the HEC-1 output was compared to the normal depth calculation to make sure the values were reasonable.

Geometry: The channel cross-section geometry used for the routes was extracted from the work map and from field observations. Several of the routing reaches are very similar in geometry and hydrologic conditions. For this reason, it was determined that typical cross-sections were adequate to represent the channel characteristics of more that one routing reach. A summary of typical cross section development and their corresponding descriptions are included in **Appendix D.3.2.**

Slopes and "n" Values: Slopes and Manning's "n" values for the routing reaches were estimated based on the topographic mapping, aerial photographs, and field observations. The normal depth routing is not very sensitive to small "n" value changes. Many routing reaches within similar areas appear to have similar hydrologic conditions. Therefore, typical "n" values were developed that represent these similar areas. **Figure HY-D.1** located in **Appendix D.3.1** shows the typical "n" value areas used in the models. The "n" values for the routing reaches were not varied between the different storm durations or development conditions models because the roughness for these well-defined channels does not change appreciably with varying depths of flow. The cross-section sketches and tabulated reach routing parameters are included in **Appendix D.3**.

Transmission losses were not estimated in this study. These losses are difficult to estimate. Currently, there are not enough stage gages in the watershed to quantify transmission losses. Because of the uncertainty, a

conservative approach was taken and potential transmission losses were ignored.

4.2.6.5 Storage Routing Parameters

Under 100-year event conditions, the design capacity of the majority of the roadway crossings would normally be exceeded, so they would not have a significant effect on the flows downstream. Additionally, very few of these crossings have a significant amount of storage, and most likely the peak flow would overtop the culverts. For this reason, only the culverts that have enough storage to affect flows were modeled using storage routing.

The CAP Canal's upstream embankment area appears to hold significant runoff, which may have some effect on downstream flooding. Therefore, the CAP Canal structures were modeled using level pool routing. There are twenty-two structures along the CAP Canal: five open overchutes and seventeen pipe crossings. Stage/discharge relationships were developed using the *Federal Highway Administration (FHA)* nomographs for culverts with inlet control (**Reference 25**) for all pipe crossings. The stage/discharge relationships for the overchutes were developed assuming critical flow conditions through the structure. The calculations are presented in **Appendix D.4.1**.

Several of the drainage structures that cross the CAP Canal are not independent, but actually work as a system. In these systems, runoff from several sources contributes to a common ponding area. The runoff could move from one structure to another, depending on the relative capacity of the cross drainage structures within the system. There are two such systems in the project boundaries and both are located east of US 60. One includes nine structures (CAP 060 [Sta. 36+12] to CAP 140 [Sta. 240+00] and the other includes five structures (CAP 150 [Sta. 253+00] to CAP190

[Sta. 315+00]). These two systems are separated by the embankment of 163rd Avenue. A combined stage/discharge and stage/storage relationship was developed for each system. These two systems work independently until the ponding water surface reaches an elevation of 1554 (Top of road elevation at 163 Avenue), and then work as a larger combined system. Initial runs of HEC-1 showed that the first system diverted flow into the second. The HEC-1 model reflects this phenomenon. Detailed calculations, including exhibits showing the CAP Canal impoundment areas, are included in **Appendix D.4.1**.

For lesser storm events (50-year or less), some of the cross drainage structures within the identified system may be independent. For larger storms (larger than 50-year) there is enough ponding to hydraulically connect the structures and cause them to function as a system.

The CAP Canal does not appear to be overtopped during the 100-year storm event. However, based on observed damage during several severe local storms in the summer of 2003, it is possible that the dike protecting the canal may not perform adequately. Analysis of potential failure of the CAP dikes was not a part of this study; it was assumed that no failures would occur along the CAP Canal. However, potential failure of the CAP may have a significant effect on downstream flows and additional analysis in the future may be required to better understand the performance of this structure

Stage/discharge relationships were also calculated for the Beardsley Canal. There are four major wash crossings with overchutes to convey runoff. There is also some storage capability behind the canal embankment. This storage was estimated using topographic data. Subbasins where no cross drainage structure was present, such as PI621,

were analyzed to determine the direction of flow along the upstream embankment of the canal. The storage area was then estimated jointly with the adjacent subbasin based on topographic data. If overtopping occurred, the flows were distributed to the different downstream basins assuming weir flow over the entire embankment length.

4.2.6.6 Flow Splits and Diversions

Portions of the watershed are characterized by distributary and braided flow and contain multiple split flow locations. Aerial photography and topographic mapping were reviewed to identify potential flow splits. Once these splits were identified, their downstream runoff was assessed and insignificant splits were ignored.

There were several natural splits that were identified as significant and methodology was developed to include them in the model. The relative magnitude of the flows traveling in each direction was estimated using normal depth flow. The relative slope, channel width, and flow resistance were used to determine the magnitude of flow contributing to each branch of the split. Detailed natural flow split calculations are included in **Appendix D.5.3**. Some of the splits were too complex to be adequately estimated using the aforementioned procedure. At these locations, a two-dimensional analysis using the *FLO-2D 2003.6.30 Dynamic Flood Routing* program (**Reference 42**) was used to estimate the split flows. Four split flow locations were identified for two-dimensional modeling. Details on the two-dimensional modeling are found in **Appendix D.5.4**.

Man-made structures also have the potential to create split flow conditions (diversions). In particular, the BNSF Railroad and US 60 allow runoff to cross the railroad through the cross drainage structure or flow along the upstream side of the embankment to a downstream structure. The relative capacity of the cross-drainage structures and the conveyance capacity of

the upstream end of the embankment were analyzed to determine diversion along the structure. Detailed calculations of diversions along the BNSF Railroad and US 60 are included in **Appendix D.5.2**.

Additional man-made split flows identified include those along the CAP Canal during larger storms. As runoff ponds behind the CAP Canal, the cross-drainage structures direct the flow to various downstream concentration points. The amount of flow that is directed to each concentration point was estimated using the capacities of the cross-draining structures. Details of these split flow calculations are included in **Appendix D.5.1**. These split flows will be discussed in more detail under the Special Problems and Solutions section of this report.

The rating curves used for the diversions at the CAP Canal were developed to reflect flow conditions during a large storm event (100-year). However, this analysis assumed that there was no failure of the CAP Canal embankment during a 100-year storm event. The possibility of failure in terms of potential location and/or mechanism of failure of the CAP Canal embankment could not be determined from the data obtained for this study and was not included in the scope of work.

4.3 Problems Encountered During the Study

4.3.1 Special Problems

The problems and solutions encountered during the study are presented below by sub-watershed.

4.3.1.1 General Area

In order to make the HEC-1 model work properly with the complex split flows and diversions in the watershed, it was necessary to create

temporary flow diversions termed "Dummy Routes". The Dummy Routes were created by diverting 100% of the flow to one concentration point and combining the remaining flow (0 %) with the next concentration point. The diversion with 100% of the flow is then later retrieved at the proper location. This occurs at concentration points CIW302 and C600A, and is documented by comment records in the models and on the HEC-1 schematic.

4.3.1.2 Picacho Wash Sub-Watershed

Runoff from this sub-watershed ponds upstream of the CAP Canal and combines with flow from the Padelford Wash and Wittmann Wash sub-watersheds. According to the model results, the CAP Canal would not be overtopped during a 100-year, storm. Therefore, this impoundment area acts as two storage systems that distribute flow among the CAP cross-drainage structures. The flow distribution was estimated based on the fourteen different structures' capacities located in this impoundment area. The outflow estimates contributing to the downstream concentration points are included in **Appendix D.5.1**.

4.3.1.3 Padelford Wash Sub-Watershed

A significant flow split was identified and field checked north of the CAP Canal. This split was modeled in the *Padelford Wash Floodplain Delineation Study* (**Reference 26**). The model developed as part of the above-mentioned study was recently approved by the District and was therefore incorporated into the model. It was originally thought that the HEC-1 model from the aforementioned project could be directly incorporated into the current HEC-1 model. However, this model included several items that would require modifications to the original model such as a different computational interval and additional JD records. HEC-1 is limited to nine JD records and it would have required

twelve to accommodate the Padelford model. Therefore, it was opted to import the hydrographs from the Padelford model as a QI record. Details on the QI records are found at the end of **Appendices D.6.1-D.6.4**.

Alternatively, the Data Storage System option of HEC-1 (DSS) was used to transfer information from *the Padelford Wash Study* model. However, because of limitations of DSS, it was decided to enter the results of the *Padelford Wash Study* model as hydrograph inputs through the use of QI cards instead of using DSS.

The *Padelford Wash Study* modeled the storage at the CAP canal. However, the study did not include the entire watershed contributing to the CAP impoundment; but included simplified assumptions to compensate. Since this study is modeling the entire area, the CAP's storage route used in the *Padelford Wash Study* model was not used. Instead the inflow hydrographs were taken prior to the storage modeling. The concentration points CO400 and CO500 were imported from *Padelford Wash Study* by means of a QI record in HEC-1.

The *Padelford Wash Study* only included existing conditions models for 24-hour and 6-hour storm events. Therefore, it was necessary to create the future models based on these exiting conditions models. To do so, a shape file was obtained from the District and a base WMS model was created. WMS was utilized to create the Green and Ampt parameters found on the LG record in HEC-1. The soils data and future land use data as shown in the appendix were used. Once the LG records were created, the 24-hour and 6-existing conditions models were altered to reflect the new Green and Ampt parameters.

During the development of the future conditions Padelford model, it was discovered that the areas for two of the subbasins (226 and 230) in the existing models did not match the area of the shape file that we received from the District. The areas were corrected in the future models, but no change was made to the existing models because the discrepancies are unlikely to significantly affect downstream flows, and the Padelford model had already been approved by the District. The District was notified of this discrepancy. The HEC-1 models for all four Padelford models (24-hr and 6-hr for existing and future conditions) are found in **Appendices D.6.1-D.6.4** following the Wittmann HEC-1 models.

There are many split flow conditions that were identified and modeled. **Figure HY-D.2** in **Appendix D.5.3** shows the locations of the natural split flows modeled and **Figure HY-D.3** in **Appendix D.5.2** shows the location of diversions created by manmade structures such as the CAP Canal, US 60, and others. Along the project boundary, there are splits that appear to leave the study area. They appear to be relatively minor, so the conservative assumption was made to include the entire flow within the study area watershed. Some other split flow locations occur near the Sarival Avenue alignment, just east of US 60. At this location, a berm was built around an old Air Force auxiliary strip. It appears that the berm causes flows to divert around the strip. This berm does not appear to be designed for a 100-year event; and most likely it would be breached early during a storm and most of the runoff would continue on its natural path. This split was not modeled because of the high probability that the structure would fail.

4.3.1.4 Wittmann Wash, Trilby Wash, and Iona Wash Sub-Watersheds

There were many split flow conditions that were identified in these three sub-watersheds. The relevance of these splits on downstream flows was estimated and only the splits that have a significant effect were modeled. Refer to **Figure D.5** in **Appendix D** for locations of the split flows.

Several diversions were identified along the BNSF Railroad and US 60. These diversions were modeled as described under the Split Flow Diversion section of this report. The crossings along the roadway appear to have similar or larger capacities than the corresponding railroad crossings. Therefore, for the majority of the split flows, the railroad was determined to be the limiting factor and the US 60 culverts were assumed to pass all flow. However, there were several exceptions found based on as-built information and field observation. Details regarding the culvert modeling can be found in **Appendix D.5.2**.

4.3.1.5 Sun Valley Parkway Sub-Watershed

The most distinguishing feature in this area is the Sun Valley Parkway, which includes many culverts. However, most of these culverts do not have significant storage to attenuate peak runoff and will not likely have a significant effect on downstream flows. Several of the culverts appear to have been designed to divert excess flows along the roadway to the next culvert in order to address over capacity flows and they function as a system. The basin boundaries in these cases were delineated to include all culverts in the system. By doing this, the need for split flow modeling was eliminated.

4.3.1.6 White Tanks Sub-Watershed

The southernmost portion of McMicken Dam was eliminated from this model because the District is planning to isolate this portion of the dam as

part of the *McMicken Dam Fissure Risk Zone Remediation Project* **(Reference 16).** As a result of this project, runoff from this small area (0.6 square miles) would no longer be contributing to the McMicken Dam impoundment area.

4.3.1.7 Central Arizona Project Canal

There are twenty-two drainage structures crossing the CAP Canal within the project area. There is considerable storage upstream of the CAP Canal, created by embankments that were constructed to protect the canal and route flows to the cross-drainage structures. Typically, one structure drains a single impoundment area. However, in one instance fourteen structures drain a single impoundment area. In this area, stage/discharge relationships were estimated based on the combined effect of all structures within this impoundment area. The outflow was divided among the different structures, depending on their relative stage discharges. The parameters used in developing the stage/storage and stage/discharge data are included in **Appendix D.4.1** and **Appendix D.5.1**.

One of the difficulties in establishing the storage volumes of impoundment areas was mapping accuracy. In certain areas, 2-foot contours were provided by the District, and in other areas only 4-foot contours were provided. In yet another area, the only available topography was 10-foot mapping. In this area, Entellus developed 2-foot contours using the ASCII grid files provided by the District. This affected structures CAP 200 and CAP 210. For the large impoundment system behind structures CAP 060 to CAP 190, contours and spot elevations show that water would overtop the lateral embankment immediately east of structure CAP 190 prior to overtopping the CAP Canal embankment. However, the water surface behind the lateral embankment would also be high. It was assumed that cross flow along this lateral embankment would be negligible, so it was ignored. Also, there is a berm of elevation 1552 between Structures

CAP140 and CAP150. This berm is four feet below the canal embankment, but still separates the impoundment area at low flows. This separation was not considered in the stage-storage calculations.

Another consideration was how the calculated storage and flow values compared to those calculated by the US Bureau of Reclamation (BOR) **(Reference 26)**. In general, flows and storage volumes for the cross-drainage structures west of US 60 closely matched the BOR design data. In other areas, the data did not match very well. In the large impoundment area east of US 60, the calculated storage volume was roughly double that of the BOR for the same outflow discharge. For the three drainage structures farthest east in the study area, the calculated storage volumes were significantly less than those of the BOR. It is likely that these differences could be better explained if the stage data from the BOR had been available during this study. Unfortunately, the only BOR data available were inflow and outflow discharge rates and total storage volumes. The differences could also be related to the difference in topographic mapping or the calculated flow rates for the structures.

Structure CAP 050 was a special case. At the time of the survey, this overchute was completely covered with sediment. Hence, there were no ground shots taken. The invert was estimated from the BOR's structure height and topographic data received from the District.

No spot elevations were available from the District's mapping along the embankment area of structure CAP 030. Therefore, the highest contour elevation was used as the overtopping elevation.

The impoundment area for structure CAP 220 extends outside the project boundary and combines with a 30-inch reinforced concrete pipe (RCP) at

station 459+30 before overtopping the berm into the canal. CAP 220 is a 72" RCP, considerably larger than the 30" RCP. Additionally, the invert of the 72" RCP is lower than the estimated 30" RCP invert. Therefore, the discharge associated with the 30-inch culvert (outside the project area) was ignored, but the impoundment storage volume outside of the project area was included.

4.3.1.8 Beardsley Canal

There are four cross drainage structures along the canal east of US 60. Basin boundaries were delineated to account for storage upstream of the canal and stage/discharge was modeled at these four locations along the canal. There is an existing berm north of the canal; however, there are no records regarding its design or maintenance and there are signs that it has failed at several different places in the past. Therefore, the berm was assumed insignificant and not modeled. Topographic mapping provided by the District was used to estimate the stage/storage relationships, the overchute capacities, and the overtopping elevation of the canal. The Maricopa County Municipal Water Conservation District was contacted in an attempt to obtain as-built information regarding the structures, but no response was received.

4.3.2 Modeling Warning and Error Messages

4.3.2.1 100-Year, 24-Hour Models

There were no error messages in the existing or future HEC-1 models. Warning messages generated by HEC-1 were examined to ensure that the models were not adversely affected. There were two warning messages encountered for the 100-year, 24-hour HEC-1 models. The first was as follows:

- WARNING EXCESS AT PONDING LESS THAN ZERO FOR PERIOD. EXCESS SET TO ZERO

This warning occurs five (5) times in the existing model and eleven (11) times in the future model. This warning appears when a negative value for ponding occurs, which happens when the soil infiltration is greater than runoff. The model automatically corrects this by setting the negative value to zero; therefore the warning was considered inconsequential.

The second warning was as follows:

- *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN (*Value*) TO (*Value*).

This warning specified a range of flows where routing might be numerically unstable. This warning occurred at sixty-nine (69) storage routing records for the existing model and at seventy-seven (77) storage routing records for the future model. In the existing model for fifty-eight (58) of the warnings the flow was outside of the unstable range and in these cases the warning is inconsequential. In the future model for sixty-one (61) of the warnings the flow was outside of the unstable range, and therefore the warning was inconsequential.

The remaining eleven (11) hydrograph flows for the existing, and sixteen (16) hydrograph flows for the future were within the range of potential instability, and were examined for oscillations. For the existing model the hydrographs were RIW387, RWT150, SSR190, SSR310, SSR330, SSR350, SSR540, SSR630, SSR830, SSR880 and SSR940. For the future model the hydrographs were RDCP16, RWT150, SCP210, SCP220, SPD704, SPD726, SSR103, SSR190, SSR310, SSR330, SSR350, SSR540, SSR630, SSR830, SSR880 and SSR940.

These hydrographs were plotted and examined for instabilities. No major instabilities were evident and so the warnings were considered inconsequential.

4.3.2.2 100-Year, 6-Hour Models

There were no error messages in the existing or future HEC-1 models. Warning messages generated by HEC-1 were examined to ensure that the models were not adversely affected. There were two warning messages encountered for the 100-year, 24-hour HEC-1 models. The first was as follows:

- WARNING EXCESS AT PONDING LESS THAN ZERO FOR PERIOD. EXCESS SET TO ZERO

This warning occurs once in the existing model and twice in the future model. This warning appears when a negative value for ponding occurs, which happens when the soil infiltration is greater than runoff. The model automatically corrects this by setting the negative value to zero; therefore the warning was considered inconsequential.

The second warning was as follows:

- *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN (*Value*) TO (*Value*).

This warning specified a range of flows where routing might be numerically unstable. This warning occurred at eighty (80) storage routing records for the existing model and at seventy-nine (79) storage routing records for the future model. In the existing model for sixty-two (62) of the warnings the flow was outside of the unstable range and in these cases the warning is inconsequential. In the future model for sixty-

two (62) of the warnings the flow was outside of the unstable range, and therefore the warning was inconsequential.

The remaining eighteen (18) hydrograph flows for the existing, and seventeen (17) hydrograph flows for the future were within the range of potential instability, and were examined for oscillations. For the existing model the hydrographs were RDCP16, RDCP19, RIW387, RPI636, RSV276, SCP210, SCP220, SPD704, SPD726, SSR103, SSR190, SSR310, SSR330, SSR540, SSR630, SSR830, SSR880 and SSR940. For the future model the hydrographs were RDCP16, RDCP19, RIW387, RPI636, RSV276, SCP210, SCP220, SPD704, SPD726, SSR190, SSR310, SSR330, SSR540, SSR630, SSR830, SSR880 and SSR940.

These hydrographs were plotted and examined for instabilities. In the future model, hydrograph SPD726 originally spiked towards the top of the hydrograph. This was due to a transition of culvert to weir flow. An additional data point was computed for this model at the elevation of 1344.1 ft. Once this was inserted the instability no longer existed. No other major instabilities were evident and so the warnings were considered inconsequential.

4.4 Calibration

There is inadequate stream gage data to accurately calibrate the model. However, results were compared to previous studies. The results of the hydrologic models and results from previous related studies are summarized in **Table HY-4.4.** Indirect methods were also used to verify results. See **Section 4.6** for a detailed discussion of the various indirect methods used. The model results appear to compare well with the limits of these other methods.

The only gaging stations within the project area with sufficient record length to provide meaningful calibration data are located at the McMicken Dam Spillway and downstream in the McMicken Outlet Channel. Both of these gages record flow after they are attenuated by the dam storage pool. Also, these stage gages only start recording after the flow depth exceeds two feet. In the period of record available, there are only a few times when the gages have registered flow. This, coupled with insufficient rain gages through the watershed, makes calibration of this model using gage data impractical.

Table HY-4.4 – Comparison of Results at Selected Concentration Points
EXISTING CONDITIONS PEAK DISCHARGE - 24-HOUR, 100-YEAR EVENT

Location	Entellus Wittmann ADMSU			WLB Group Wittmann ADMS 1989 (cfs)	Bonita Dam Hydrologic Study 2002 (cfs)	Trilby Wash FIS 1991 (cfs)
	CP	Area (sq. mi.)	Flow (cfs)			
McMicken Outlet Wash inflow	C802*	313.51	7,101	5,928	N/A	N/A
McMicken Dam upstream of spillway	CWI500	222.82	21,372	20,431	N/A	N/A
Lake Bonita Dam	C726B	19.77	1,298	1,448	1,395	N/A
Trilby Wash Upstream of US 60	CIW370	12.05	5,663	2,785	N/A	2,785
Trilby Wash Upstream of CAP	CIW334	22.85	5,156	3,851	N/A	3,851
Iona Wash Upstream from CAP	CIW314	29.09	7,496	5,309	N/A	N/A
Confluence of Trilby and Iona Washes	C410*	104.45	14,102	11,427	N/A	N/A

4.5 Results of Hydrologic Analysis

Complete results of the hydrologic analysis including the HEC-1 input and output files are presented in **Appendix D.6.** A summary of peak discharges is shown in **Appendix D.6.5**. As expected, the 24-hour storm controls for the larger contributing areas, and the 6-hour storm controls for smaller contributing areas. The 24-hour

storm will utilized for the floodplain delineation. In general, the flows obtained were significantly higher than what has been obtained in previous studies. **Table HY-4.4** shows a few examples of these increased flow changes. This can be attributed to differences in methodologies as well as increased development in the area.

4.6 Verification of Results

The District has established a chart to describe the general relationship between peak discharges and watershed size for Maricopa County (**Reference 17**). For this study, the estimated peak discharges were plotted on the District's chart for comparison purposes. **Figures HY-D.4 through D.7** contain the verification of results and are found in **Appendix D.6.5**.

Figures HY-D.4 and **D.5** utilize a flood frequency analysis by the District (**Reference 43**). As shown by the figures, the bulk of the flows are slightly below average. Since the data encompasses the gage data for the entire Maricopa County, and the Wittmann watershed has, in general, very sandy soil and flat slopes, peak flows slightly below average are expected.

Figures HY-D.6 and **D.7** utilize two indirect methods: LP3 Regression Curve and the Region 12 Regression Equation. The LP3 Regression Curve, as taken from the Hydrology Manual, is calculated as $Q_{100} = 850 * A^{0.54}$. The 75% Confidence Limits are taken from the data used to generate this LP3 Regression Curve. This data contains 314 continuous or partial record gaging stations throughout Arizona and is contained in the Hydrology Manual. The Region 12 Regression Equation, as found in the Hydrology Manual is $LOG(Q_{100}) = 6.55-3.17*AREA^{-0.11}-0.454*LOG(ELEV)$, where ELEV is the mean basin elevation in feet divided by 1000. This value was determined on a weighted basis for all subbasins in the watershed. 1.932 was the value utilized.

From **Figures D.6** and **D.7**, there appear to be several points below the 75th percentile confidence line. Upon examination, all of these points were found to be downstream of the CAP and/or downstream of the McMicken Dam Spillway. Therefore, it can be concluded that the attenuation of peak flow caused by the CAP Canal and McMicken Dam causes these points to fall below the 75th percentile confidence limits. The remaining data fall between the 75th percentile confidence limits.

SECTION HY-5: HYDRAULICS

The contents of this section are located in: *Volume HD – Floodplain Delineation* (**Section 5. Hydraulics**) of "*Wittmann Area Drainage Master Study Update Report.*"

SECTION HY-6: EROSION AND SEDIMENT TRANSPORT

The contents of this section are not a part of this report.

HALF SIZED PLATES

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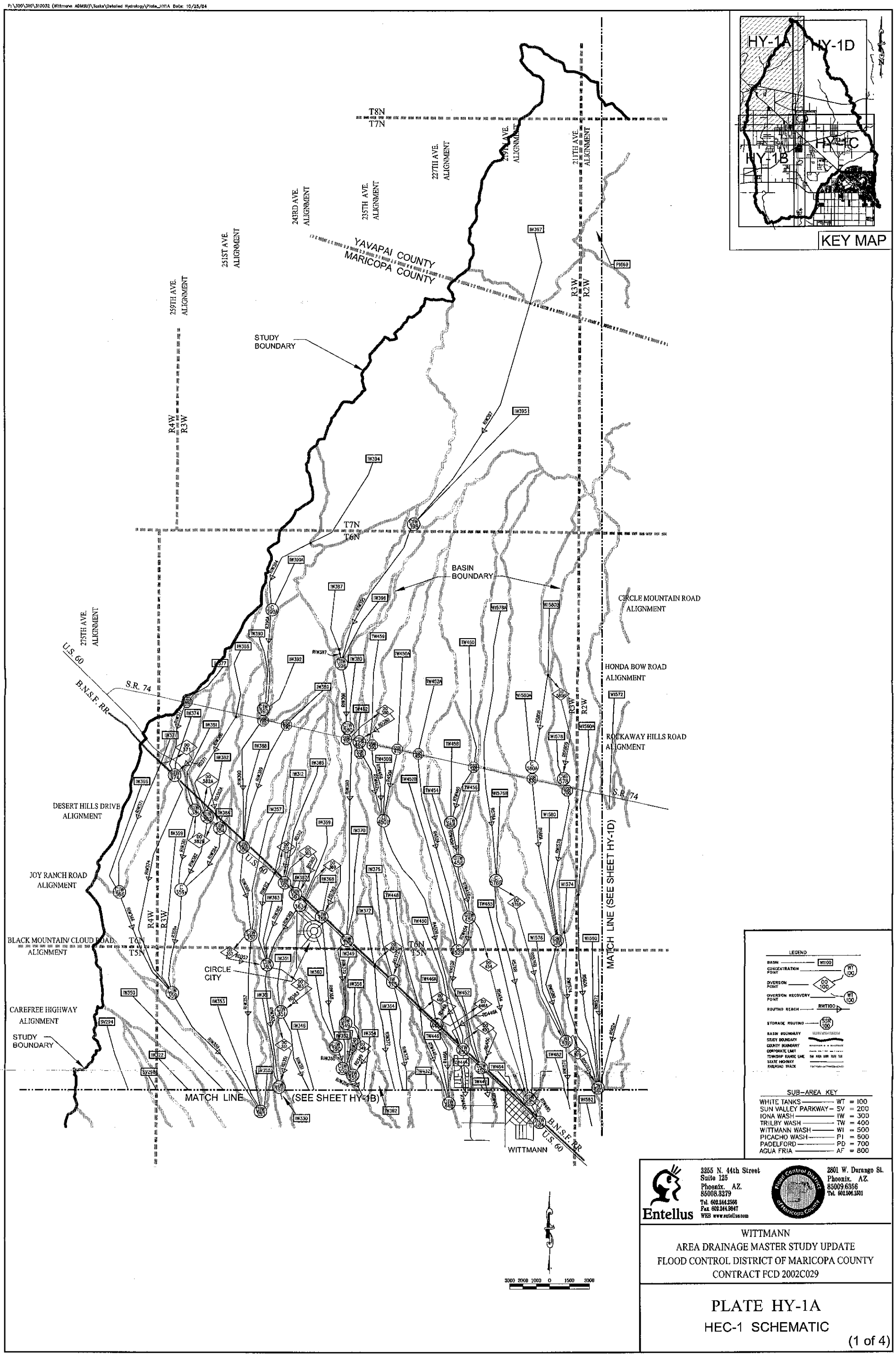

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PLATE HY-1A

HEC-1 SCHEMATIC

(1 of 4)

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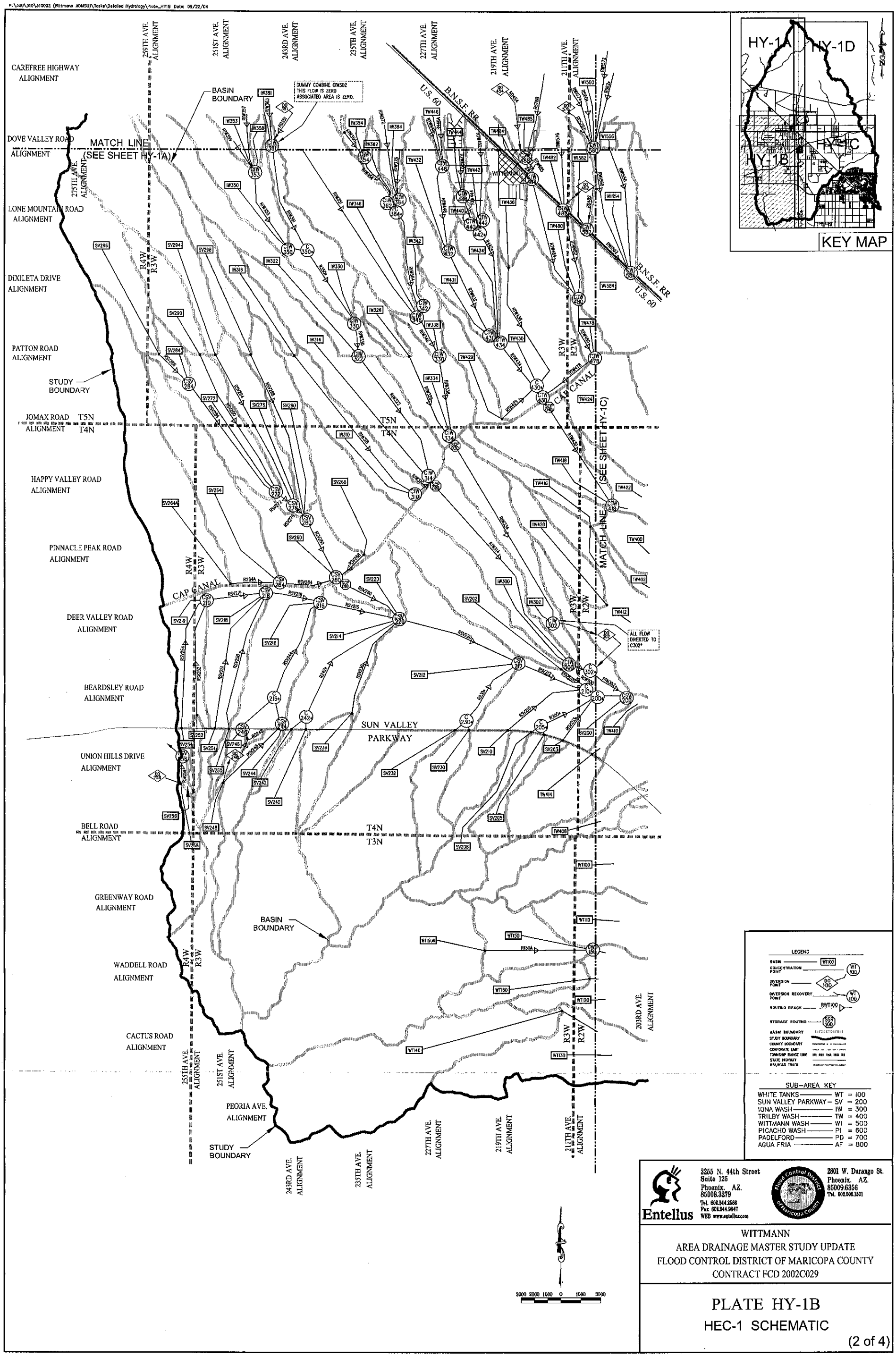

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PLATE HY-1B

HEC-1 SCHEMATIC

(2 of 4)

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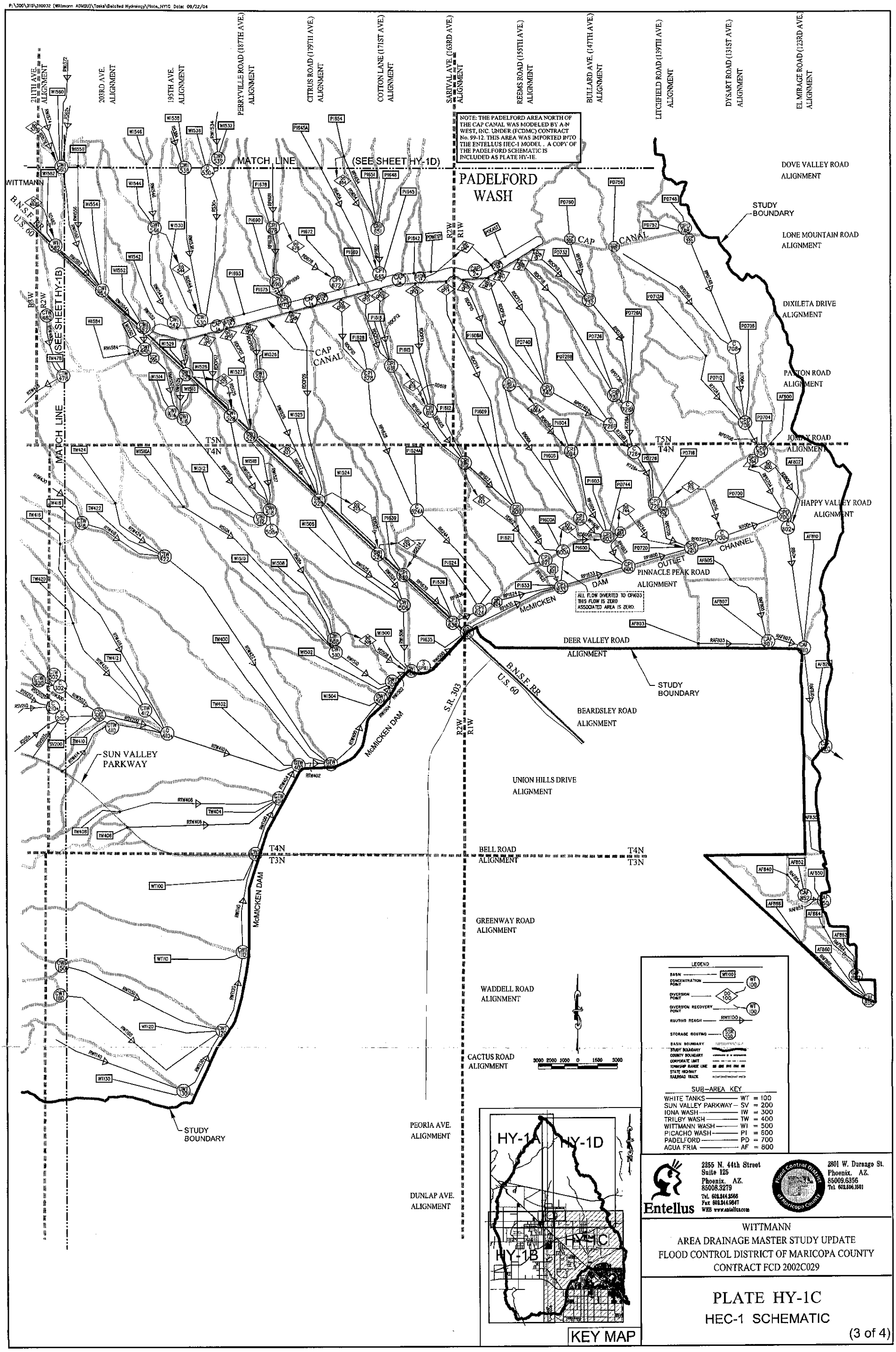

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PLATE HY-1C

HEC-1 SCHEMATIC

(3 of 4)

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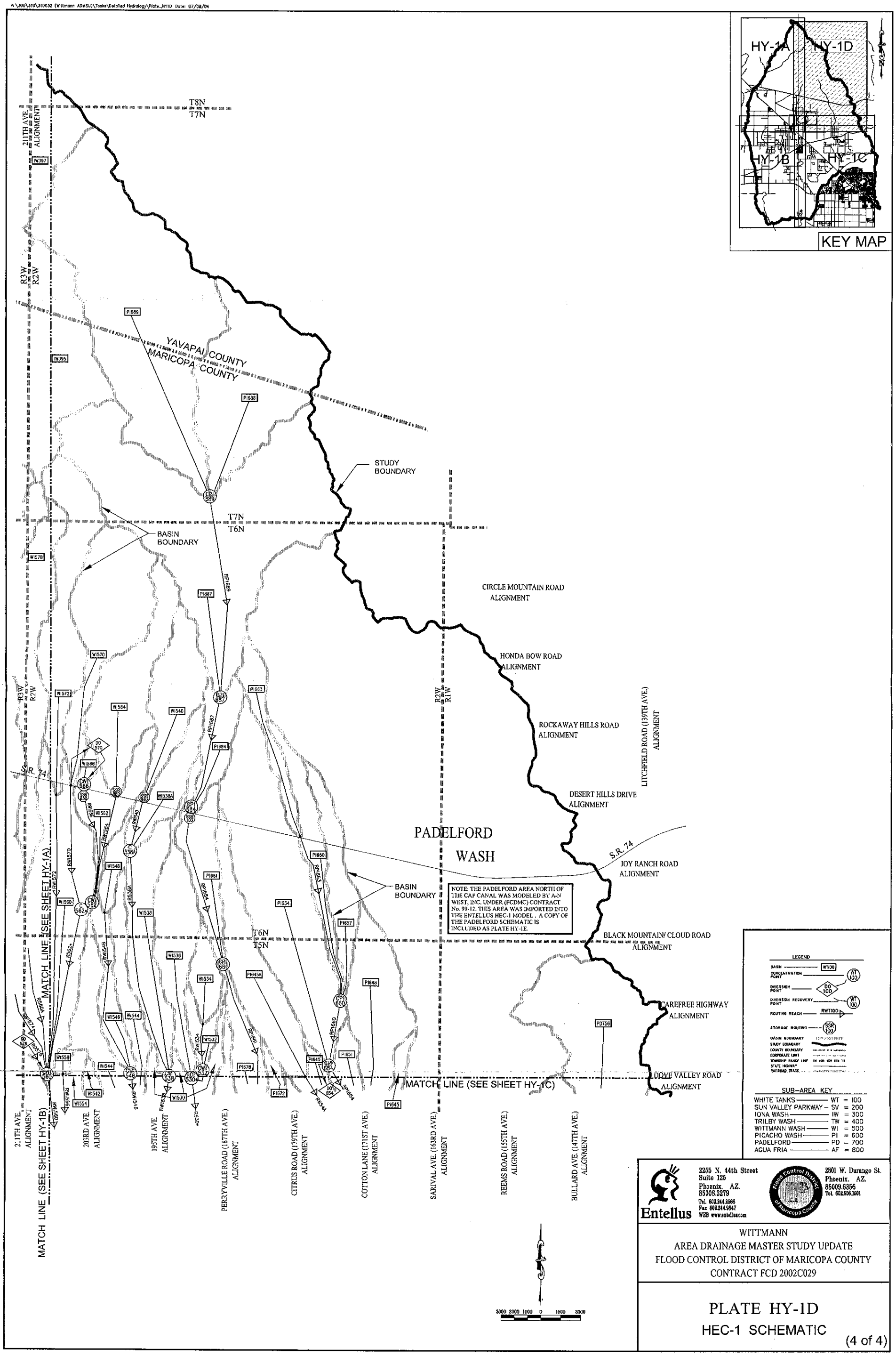

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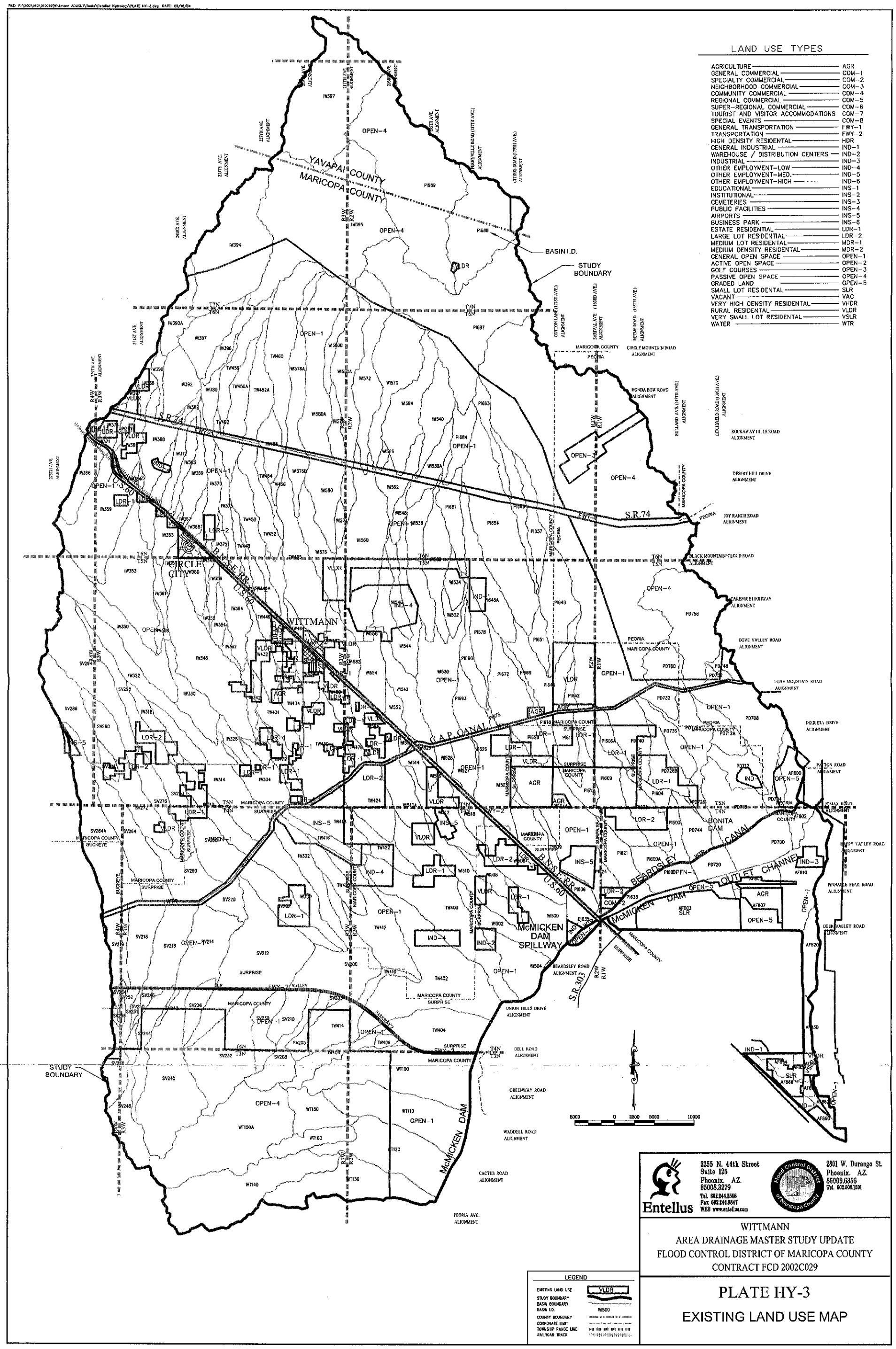
PLATE HY-1D

HEC-1 SCHEMATIC

(4 of 4)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GENERAL COMMERCIAL — COM-1
SPECIALTY COMMERCIAL — COM-2
NEIGHBORHOOD COMMERCIAL — COM-3
COMMUNITY COMMERCIAL — COM-4
REGIONAL COMMERCIAL — COM-5
SUPER-REGIONAL COMMERCIAL — COM-6
TOURIST AND VISITOR ACCOMMODATIONS — COM-7
SPECIAL EVENTS — COM-8
GENERAL TRANSPORTATION — FWY-1
TRANSPORTATION — FWY-2
HIGH DENSITY RESIDENTAL — HDR
GENERAL INDUSTRIAL — IND-1
WAREHOUSE / DISTRIBUTION CENTERS — IND-2
INDUSTRIAL — IND-3
OTHER EMPLOYMENT-LOW — IND-4
OTHER EMPLOYMENT-MED. — IND-5
OTHER EMPLOYMENT-HIGH — IND-6
EDUCATIONAL — INS-1
INSTITUTIONAL — INS-2
CEMETERIES — INS-3
PUBLIC FACILITIES — INS-4
AIRPORTS — INS-5
BUSINESS PARK — INS-6
ESTATE RESIDENTIAL — LDR-1
LARGE LOT RESIDENTIAL — LDR-2
MEDIUM LOT RESIDENTAL — MDR-1
MEDIUM DENSITY RESIDENTAL — MDR-2
GENERAL OPEN SPACE — OPEN-1
ACTIVE OPEN SPACE — OPEN-2
GOLF COURSES — OPEN-3
PASSIVE OPEN SPACE — OPEN-4
GRADED LAND — OPEN-5
SMALL LOT RESIDENTAL — SLR
VACANT — VAC
VERY HIGH DENSITY RESIDENTAL — VHDR
RURAL RESIDENTAL — VLDR
VERY SMALL LOT RESIDENTAL — VSLR
WATER — WTR
YAVAPAI COUNTY
MARICOPA COUNTY
BASIN I.D.
STUDY BOUNDARY
S.R.74
U.S.60
B.N.S.F. RR
CIRCLE CITY
WITTMANN
C.A.P. CANAL
BEARDSLEY WTR CANAL
OUTLET CHANNEL
McMICKEN DAM
McMICKEN DAM SPILLWAY
BONITA DAM
S.R.303
LEGEND
EXISTING LAND USE
STUDY BOUNDARY
BASIN BOUNDARY
BASIN I.D.
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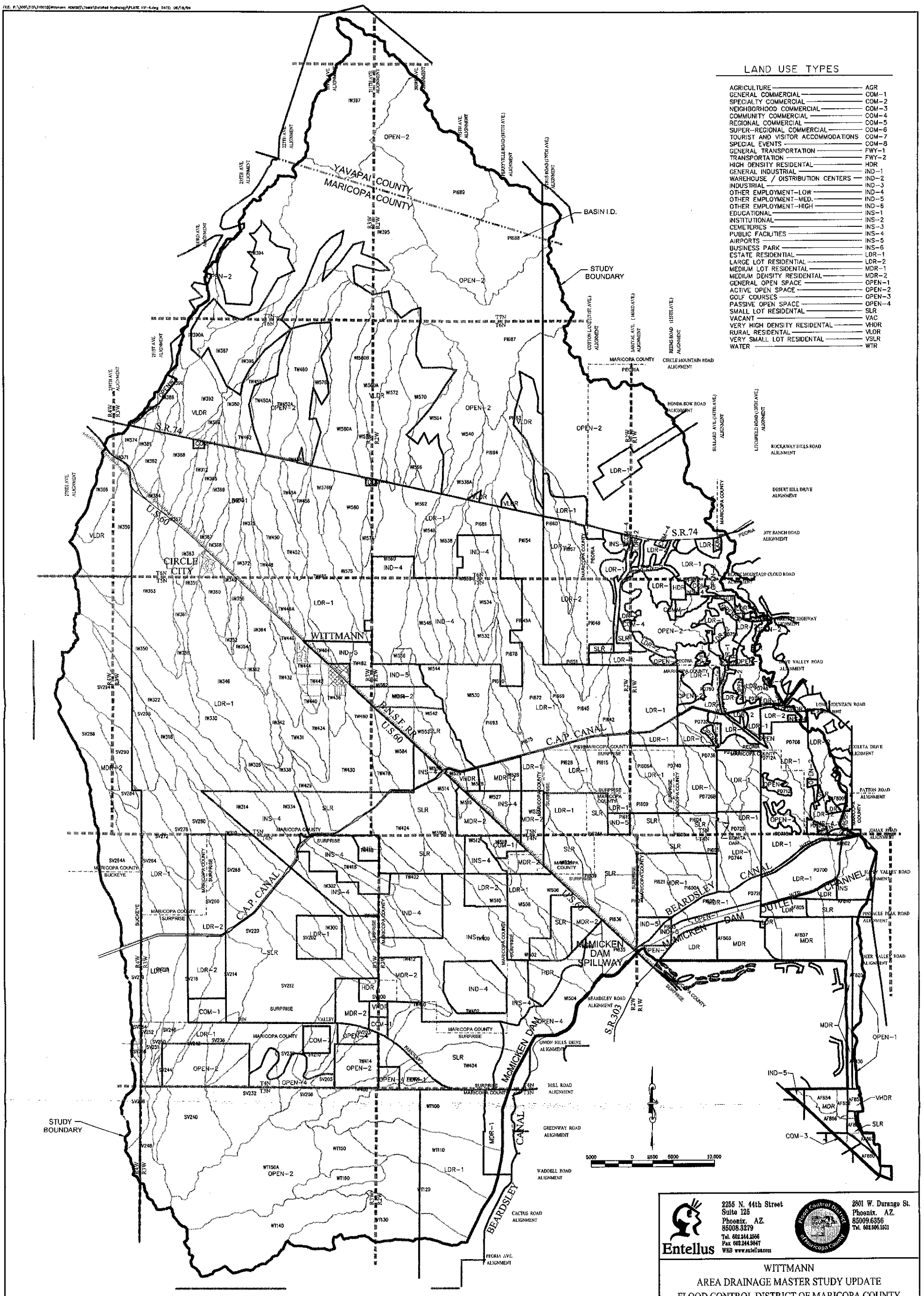
PLATE HY-3
EXISTING LAND USE MAP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LEGEND
FUTURE LAND USE
STUDY BOUNDARY
BASIN BOUNDARY
BASIN I.D.
COUNTY BOUNDARY
CORPORATE LIMIT
TOWNSHIP RANGE LINE
RAILROAD TRACK
PLATE HY-4
FUTURE LAND USE MAP

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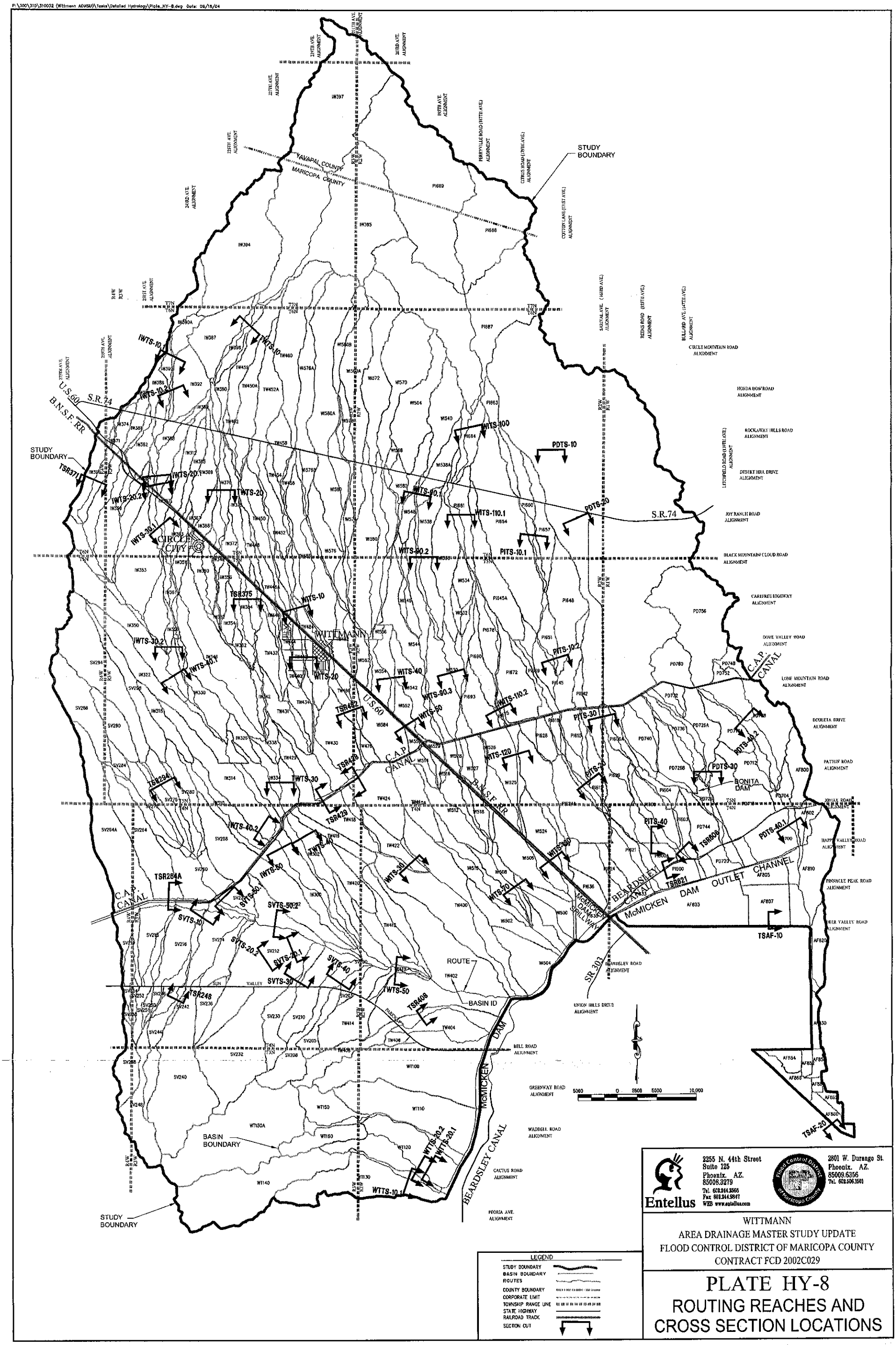

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PLATE HY-8
ROUTING REACHES AND CROSS SECTION LOCATIONS

LEGEND
- STUDY BOUNDARY
- BASIN BOUNDARY
- ROUTES
- COUNTY BOUNDARY
- CORPORATE LIMIT
- TOWNSHIP RANGE LINE
- STATE HIGHWAY
- RAILROAD TRACK
- SECTION CUT

APPENDIX A. REFERENCES

A.1. Data Collection Summary

A.2. Reference Documents

APPENDIX A. REFERENCES

A.1. Data Collection Summary

All the data collected to obtain the information in this report are identified in the Data Collection Report. This report includes complete bibliographic information of the documents and references used in this report.

A.2. Reference Documents

1 USGS DEM contour mapping composed ASCI Grid file for portions of the study area, by *Landata Inc.*, June 2002.

2 10ft contour mapping composed ASCI Grid file for portions of the study area, by Landata Inc., June 2002.

3 4ft contour mapping composed ASCI Grid file for portions of the study area, by Landata Inc., June 2002.

4 2ft contour mapping composed ASCI Grid file for portions of the study area, by Landata Inc., June 2002

5 Soil Survey of Maricopa County, Arizona-Central Part, by *U.S. Department of Agriculture*, April 1986.

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17 Flood Frequency Analysis of Stream Flow Stations, by *Flood Control District of Maricopa County*, Internal Memorandum, R. Cruff, April 1996.

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27 CAP Granite Reef Aqueduct, Location Map Reach 8 & 9, *US Department of the Interior and Bureau of Reclamation,* 1974.

28 US Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *Generalized Computer Program 723-X6-L2010, HEC-1 Flood Hydrograph Package*, Davis California, February 1981, Revised May 1991.

29 S-Graph Study, Contract FCD 86-36, by George V. Sabol Consultant Engineer for the *Flood Control District of Maricopa County, Arizona*, November 1987.

30 Precipitation Summary, Arizona, by *Western Regional Climate Center*, August 2003.

31 Temperature Summary, Arizona, Western Regional Climate Center, by *Western Regional Climate Center*, August 2003.

32 Urban Hydrology for Small Watersheds, Technical Release 55, by U.S. Department of Agriculture, Soil Conservation Service, June 1986.

33 Rainfall Frequency Atlas of the Western U.S, by *Western Regional Climate Center*, August 2003.

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42 FLO-2D, J. S. O'Brien, 2003

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APPENDIX B. GENERAL DOCUMENTATION AND CORRESONDENCE

The entire content of this appendix is located in Administrative Report - Volume AR

APPENDIX B

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APPENDIX C. SURVEY FIELD NOTES

The entire content of this appendix is located in

Report of Survey - Volume SR

APPENDIX C

Entellus

APPENDIX D. HYDROLOGY ANALYSIS SUPPORTING DOCUMENTATION

D.1. Precipitation Data

D.1.1. 100-yr 24-hr Data

D.1.2. 100-yr 6-hr Data

D.1.3. Gage Data

D.2. Physical Parameter Calculations

D.2.1. Soils

D.2.2. Land Use

D.2.3. Time of Concentration

D.2.4. Hydraulic Length and Slope

D.2.5. S-Graphs

D.3. Hydrograph Routing Data

D.4. Storage Routing Data

D.4.1. CAP Canal

D.4.2. Beardsley Canal

D.4.3. SR 74

D.5. Flow Splits and Diversions Data

D.5.1. CAP Split Data

D.5.2. US 60 (Grand Ave) Diversion Data

D.5.3. Natural Diversion Data

D.5.4. 2-Dimensional Modeling Diversion Data

D.6. Hydrologic Calculations

D.6.1. 100-yr, 24-hr Existing Conditions Model Output

D.6.2. 100-yr, 6-hr Existing Conditions Model Output

D.6.3. 100-yr, 24-hr Future Conditions Model Output

D.6.4. 100-yr, 6-hr Future Conditions Model Output

D.6.5. Calibration Data

D.1. Precipitation Data

D.1.1. 100-yr 24-hr Data

D.1.2. 100-yr 6-hr Data

D.1.3. Gage Data

D.1.1. 100-yr 24-hr Data

Flood Control District of Maricopa County
EXAMPLE2 - Single Storm, 24 Hr, Green Ampt, S-Graph, Normal Depth
Rainfall Data

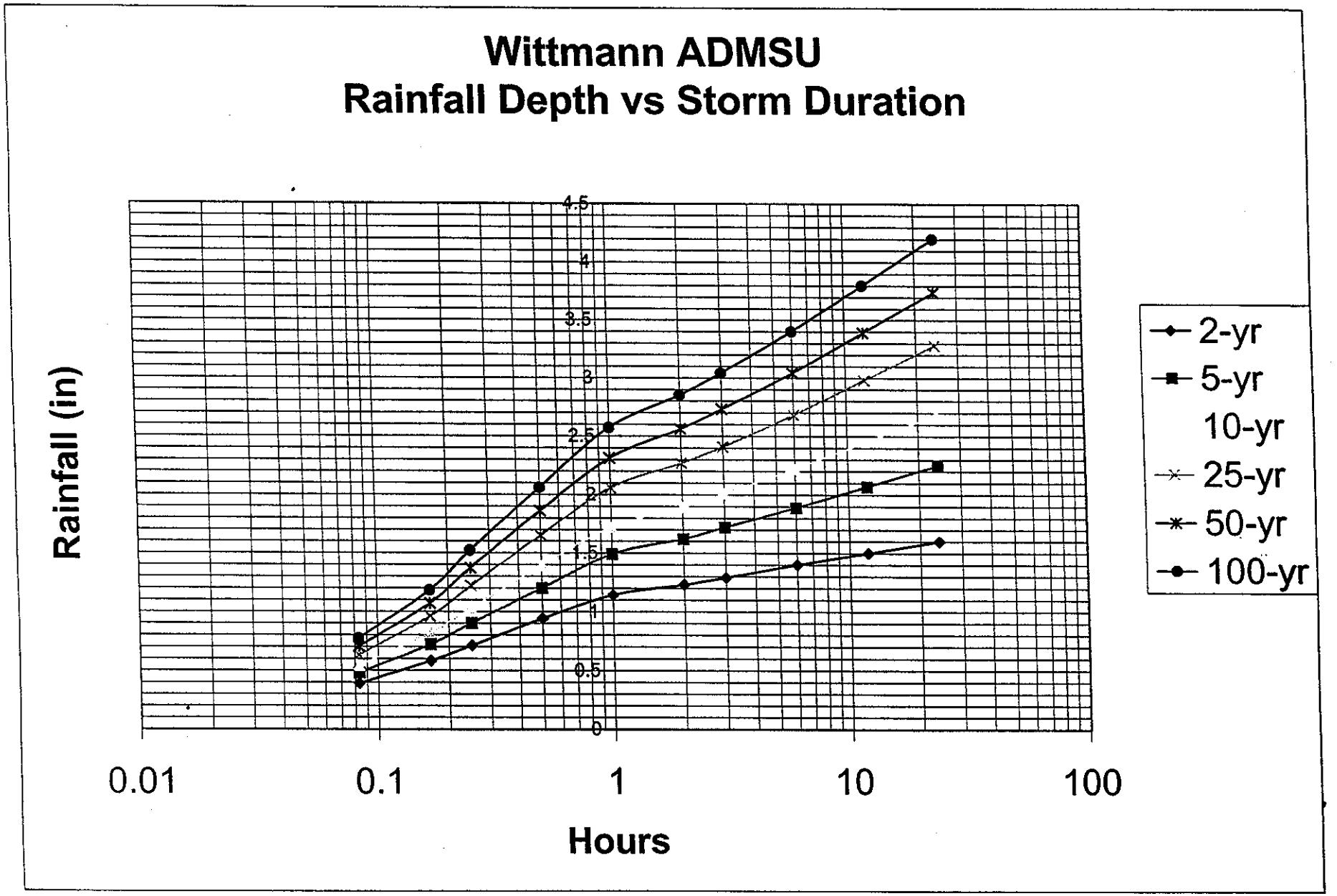
 9/02/2003

Primary Zone Number: 7 Latitude: 0.0 Elevation: 0

Short Duration Zone Number: 8 Longitude: 0.0

	Point Values (in)						
Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-yr
5 MIN	0.39	0.48	0.54	0.63	0.70	0.77	0.93
10 MIN	0.58	0.72	0.82	0.96	1.07	1.18	1.44
15 MIN	0.71	0.90	1.03	1.22	1.37	1.52	1.86
30 MIN	0.94	1.20	1.39	1.65	1.86	2.06	2.53
1 HOUR	1.14	1.49	1.72	2.06	2.31	2.57	3.17
2 HOUR	1.23	1.62	1.89	2.27	2.56	2.85	3.53
3 HOUR	1.29	1.72	2.01	2.41	2.73	3.04	3.77
6 HOUR	1.40	1.89	2.22	2.68	3.04	3.40	4.22
12 HOUR	1.50	2.07	2.45	2.98	3.39	3.80	4.74
24 HOUR	1.60	2.25	2.68	3.28	3.74	4.20	5.26

APPENDIX D.1.1



APPENDIX D.1.1

Wittmann ADMSU McMicken Dam Hydrology
HEC-1 Data for 100-yr 24-hour Distribution

JD	4.2	0.01								
PC	0	0.002	0.005	0.008	0.011	0.014	0.017	0.02	0.023	0.026
PC	0.029	0.032	0.035	0.038	0.041	0.044	0.048	0.052	0.056	0.06
PC	0.064	0.068	0.072	0.076	0.08	0.085	0.09	0.095	0.1	0.105
PC	0.11	0.115	0.12	0.126	0.133	0.14	0.147	0.155	0.163	0.172
PC	0.181	0.191	0.203	0.218	0.236	0.257	0.283	0.387	0.663	0.707
PC	0.735	0.758	0.776	0.791	0.804	0.815	0.825	0.834	0.842	0.849
PC	0.856	0.863	0.869	0.875	0.881	0.887	0.893	0.898	0.903	0.908
PC	0.913	0.918	0.922	0.926	0.93	0.934	0.938	0.942	0.946	0.95
PC	0.953	0.956	0.959	0.962	0.965	0.968	0.971	0.974	0.977	0.98
PC	0.983	0.986	0.989	0.992	0.995	0.998	1			
JD	3.948	10								
JD	3.78	30								
JD	3.612	60								
JD	3.553	90								
JD	3.503	120								
JD	3.465	150								
JD	3.36	300								
JD	3.276	500								

Note: This data was generated using DDMSW version 1.8.

APPENDIX D.1.1.

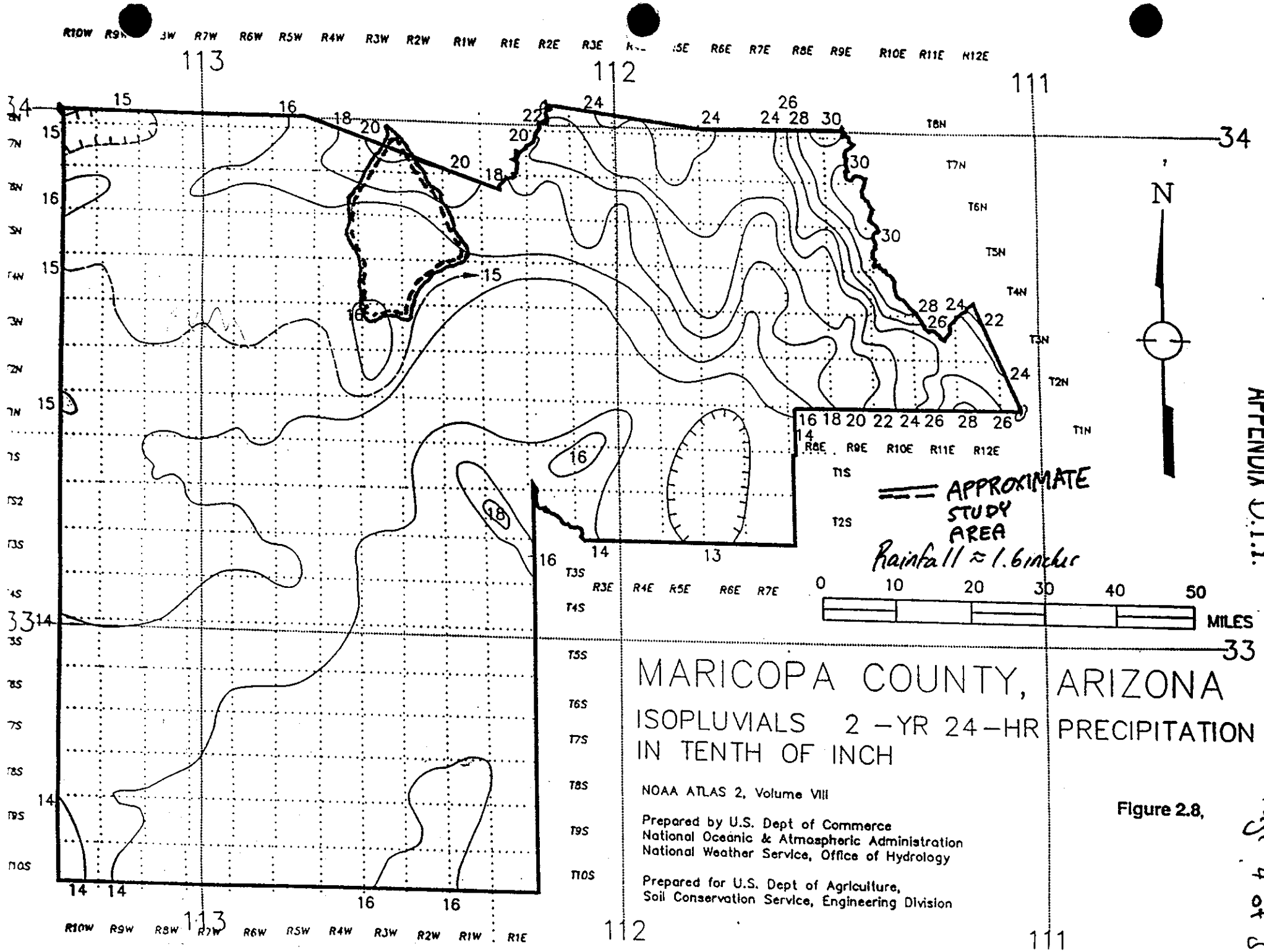


Figure 2.8,

APPENDIX D.1.1.

Page 4 of 5

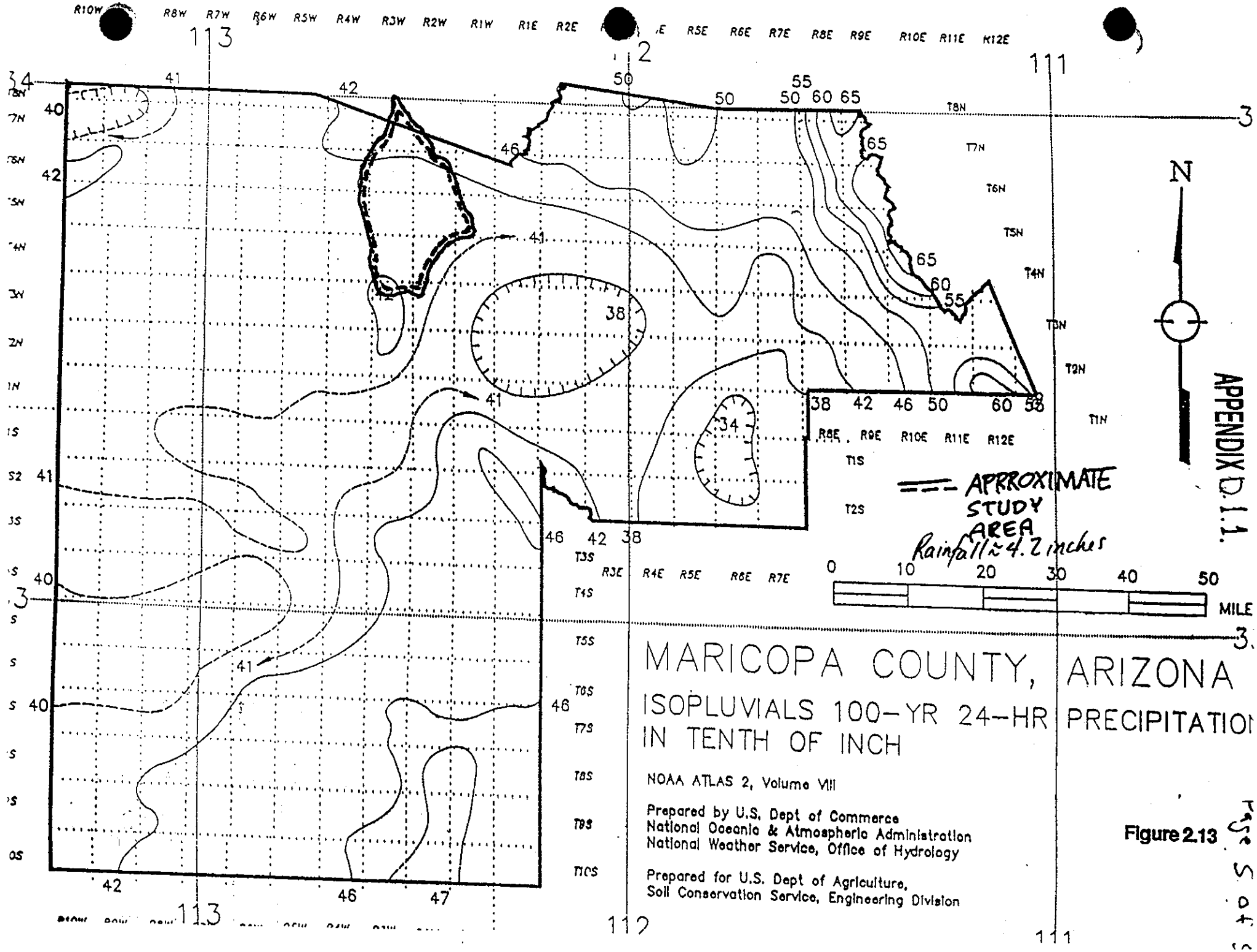

MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 100-YR 24-HR PRECIPITATION
IN TENTH OF INCH
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division
APPROXIMATE STUDY AREA
Rainfall ≈ 4.2 inches
N
0 10 20 30 40 50
MILE
APPENDIX D.1.1.

Figure 2.13

D.1.2. 100-yr 6-hr Data

Wittmann ADMSU McMicken Dam Hydrology
HEC-1 Data for 100-yr 6-hour Distribution

JD	3.4	0.01								
PC	0	0.008	0.016	0.025	0.033	0.041	0.05	0.058	0.066	0.074
PC	0.087	0.099	0.118	0.138	0.216	0.377	0.834	0.911	0.931	0.95
PC	0.962	0.972	0.983	0.991	1					
JD	3.378	0.5								
JD	3.314	2.8								
PC	0	0.009	0.016	0.025	0.034	0.042	0.051	0.059	0.067	0.076
PC	0.087	0.1	0.12	0.163	0.252	0.451	0.694	0.837	0.9	0.938
PC	0.95	0.963	0.975	0.988	1					
JD	3.135	16								
PC	0	0.009	0.02	0.03	0.048	0.063	0.076	0.09	0.105	0.119
PC	0.135	0.152	0.175	0.222	0.304	0.472	0.67	0.796	0.868	0.912
PC	0.946	0.96	0.973	0.987	1					
JD	2.761	90								
PC	0	0.021	0.035	0.051	0.071	0.087	0.105	0.125	0.143	0.16
PC	0.179	0.201	0.232	0.281	0.364	0.5	0.658	0.773	0.841	0.888
PC	0.927	0.945	0.964	0.982	1					
JD	1.938	500								
PC	0	0.024	0.043	0.059	0.078	0.098	0.119	0.141	0.162	0.186
PC	0.212	0.239	0.271	0.321	0.408	0.515	0.627	0.735	0.814	0.864
PC	0.907	0.93	0.954	0.977	1					

Note: This data was generated using DDMSW version 1.8.

APPENDIX D.1.2.

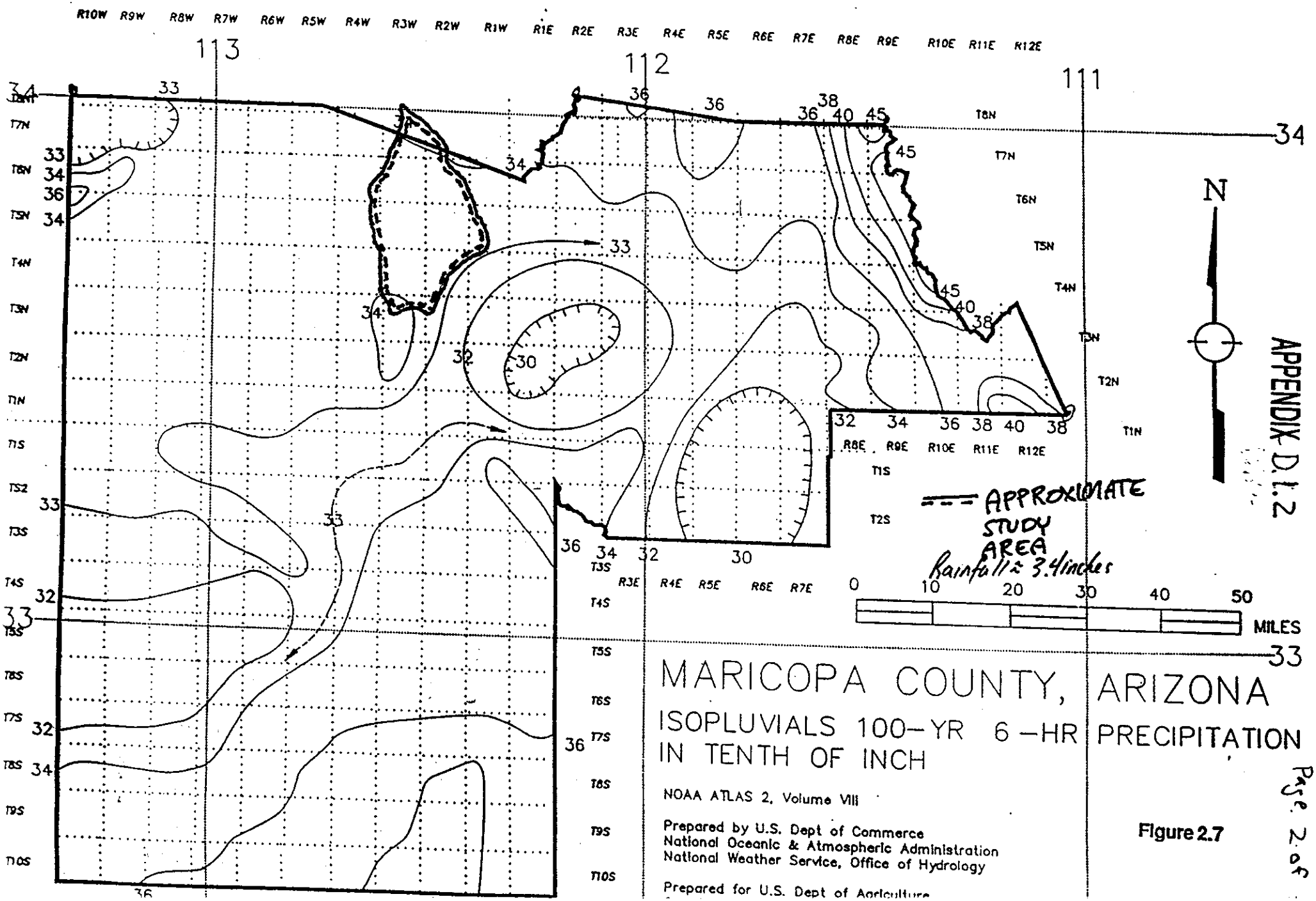
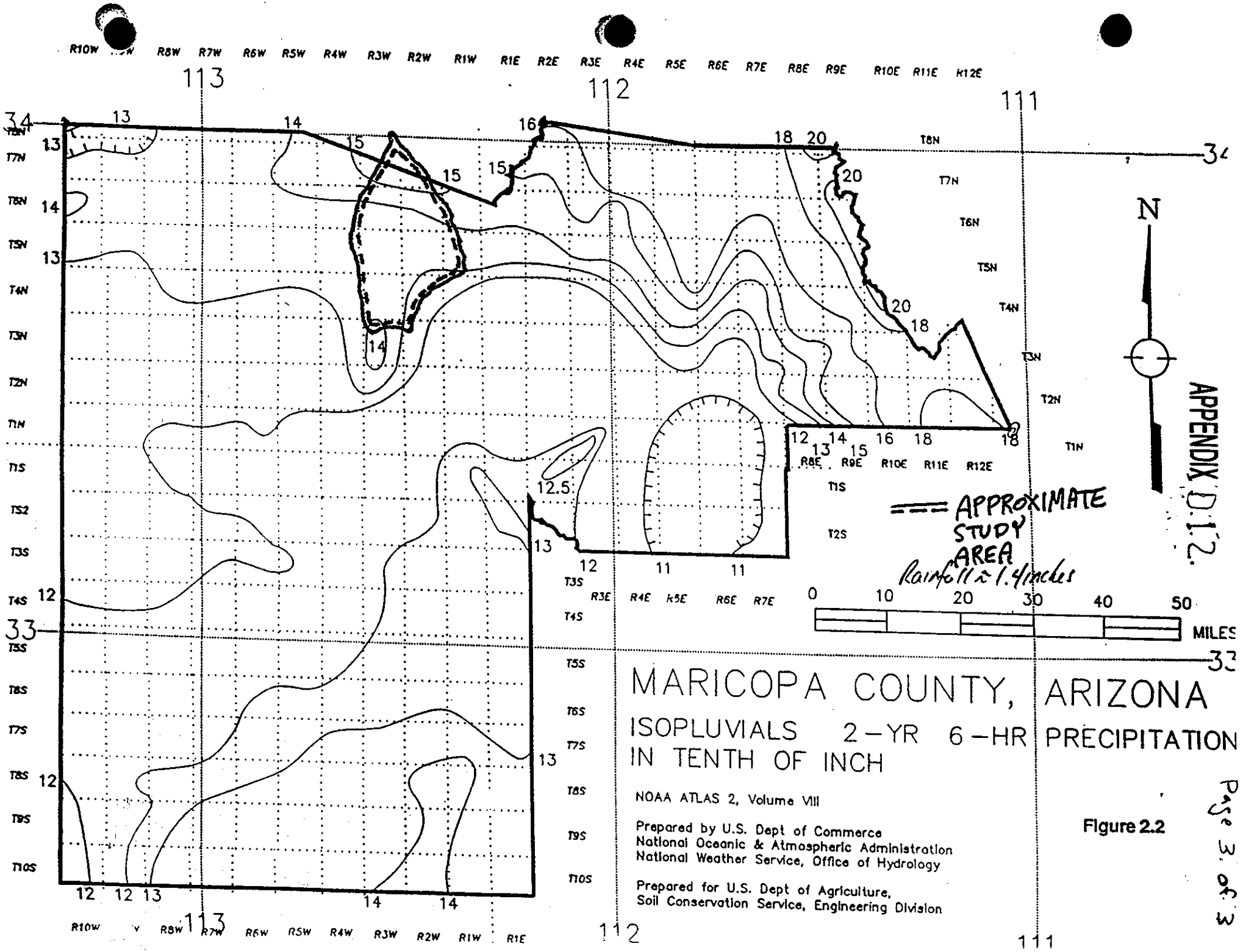


Figure 2.7

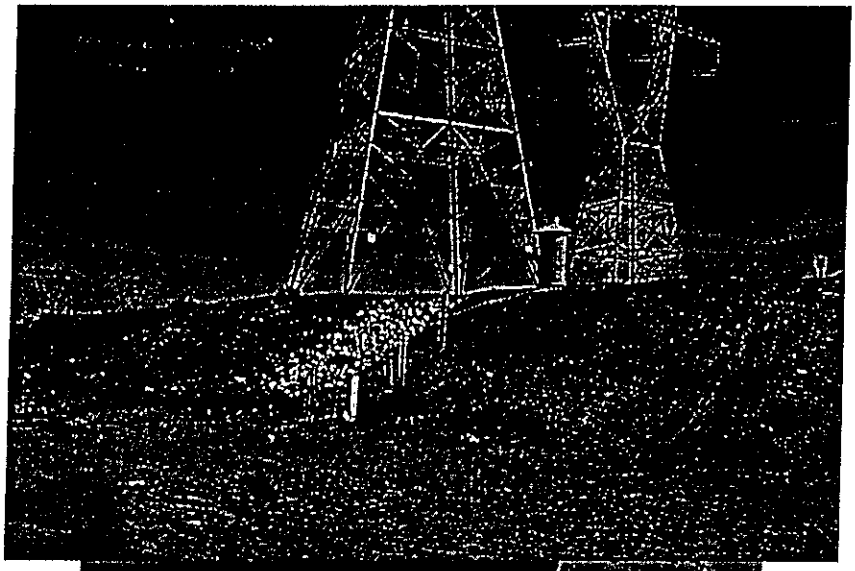
APPENDIX D.1.2

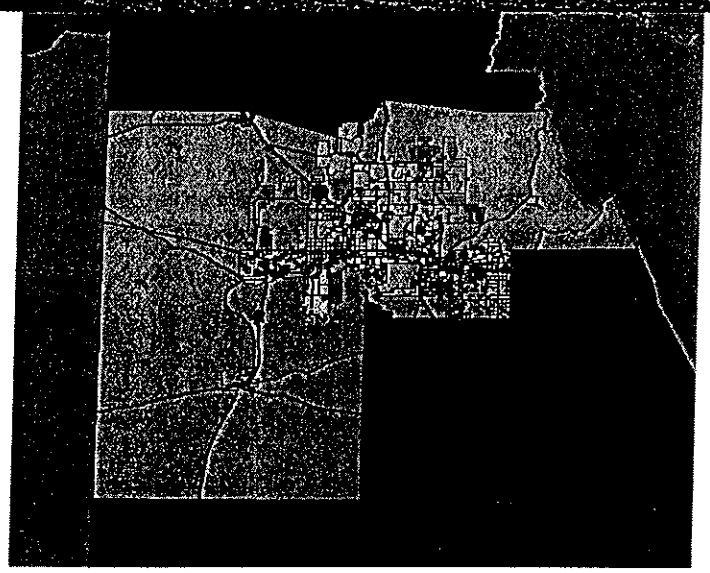
Page 2 of


APPENDIX D.12.
N
APPROXIMATE STUDY AREA
Rainfall ≈ 1.4 inches
0 10 20 30 40 50
MILES
MARICOPA COUNTY, ARIZONA
ISOPLUVIALS 2-YR 6-HR PRECIPITATION
IN TENTH OF INCH
NOAA ATLAS 2, Volume VIII
Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division
Figure 2.2
Page 3 of 3

D.1.3. Gage Data

STATION: McMicken Floodway GAGE ID: 5438





HOVER CURSOR OVER PHOTOS AND ICONS FOR DESCRIPTION AND SELECT ANY FOR FURTHER INFORMATION

FCD CURRENT CONDITIONS | STATION DESCRIPTION | RATING CURVE | RATING TBL (PDF) | GAGE X-SECTION

GAGE ID HISTORY | SITE DATA | RATING IN BRIEF | WATER YEAR PEAKS | RUNOFF HISTORY | FLOOD FLOW FREQUENCY

CREST GAGES | STAFF GAGES

Maricopa County Flood Control District Gage Information, www.fcd.maricopa.gov/services/ALERT, May 2008

Gage site is near the intersection of 163rd Avenue and Grand Avenue (US60). Instrumentation is located on the right bank of McMicken Floodway downstream of Grand Avenue.

GAGE ID HISTORY

ID	Elev of Instr. in GH	Elev of Instr. in M.S.L.	Period
5438	0.15	1,323.32	9/3/92 - present
Chart	Undetermined	Undetermined	5/19/92 - 9/3/92

SITE DATA

DRAINAGE AREA	305 MI^2
JURISDICTION	SURPRISE, ARIZONA
WATERSHED	TRILBY
SECTION/TOWNSHIP/RANGE	NW1/4 SW 1/4 S18 T4N R1W
LATITUDE	N33 41 04
LONGITUDE	W112 24 33
USGS QUAD MAP	McMICKEN DAM 7.5-MINUTE
INSTALLATION DATE	MAY 19, 1992 (WY 1992)
LENGTH OF RECORD (AS OF 10/01/02)	10.37 YEARS
STAGE GAGE TYPE	PRESSURE TRANSDUCER
STAFF GAGE	TWO, UPSTREAM OF BRIDGE
CREST STAGE GAGE	TWO
ZERO GAGE HEIGHT ELEVATION	1,323.17 FEET M.S.L.
STAGE GAGE ELEVATION	0.15 FEET GAGE HEIGHT
POINT OF ZERO FLOW	0.00 FEET GAGE HEIGHT
	JULY 15, 1999 &

PEAK FLOOD	98 CFS	1.65 FEET G.H.	JULY 31, 1992

RATING INFORMATION

RATING TABLE			
CURRENT RATING NUMBER 1, DATED MAY 19, 1992			
GAGE HEIGHT (FEET)	DISCHARGE (CFS)	GAGE HEIGHT (FEET)	DISCHARGE (CFS)
0.00	0	9.00	4,202
1.00	48	11.00	6,524
3.00	355	13.00	9,366
5.00	1,123	14.00	10,728
7.00	2,395	14.06	11,822

WATER YEAR PEAKS

Water Year	Peak Gage Height (feet)	Peak Discharge (cfs)	Date of Peak
2003			
2002	2.20	180	9/7/02
2001	0.35	8	10/27/00
2000	0.25	6	3/5/00
1999	1.65	98	7/15/99
1998	1.08	53	2/17/98
1997	0.25	6	9/25/97
1996	1.08	53	7/15/96
1995	0.15	0	---
1994	0.15	0	---
1993	1.15	59	1/11/93

Maricopa County Flood Control District Gage Information, www.fcd.maricopa.gov/services/ALERT, May 2008

1992	1.65	98	7/31/92

RUNOFF EVENT HISTORY

ANNUAL REPORT
MEAN DAILY FLOW

Event Date	Peak Stage feet G.H.	Peak Discharge (cfs)	Water Year
9/7/02	2.20	180	2002
7/24/02	1.42	80	2002
9/20/99	1.38	76	1999
7/15/99	1.65	98	1999
2/17/98	1.08	53	1998
7/15/96	1.08	53	1996
1/11/93	1.15	59	1993
9/20/92	1.05	52	1992
7/31/92	1.65	98	1992

FLOOD FLOW FREQUENCY

Flood Flow Frequency (FEMA 9/95, "at confluence with McMicken Dam")		
Magnitude and Probability of Instantaneous Peak Flow		
Discharge, in cfs, for Indicated Recurrence Interval		
10-year	50-year	100-year
2,610	4,280	5,090

CREST STAGE GAGE INFORMATION

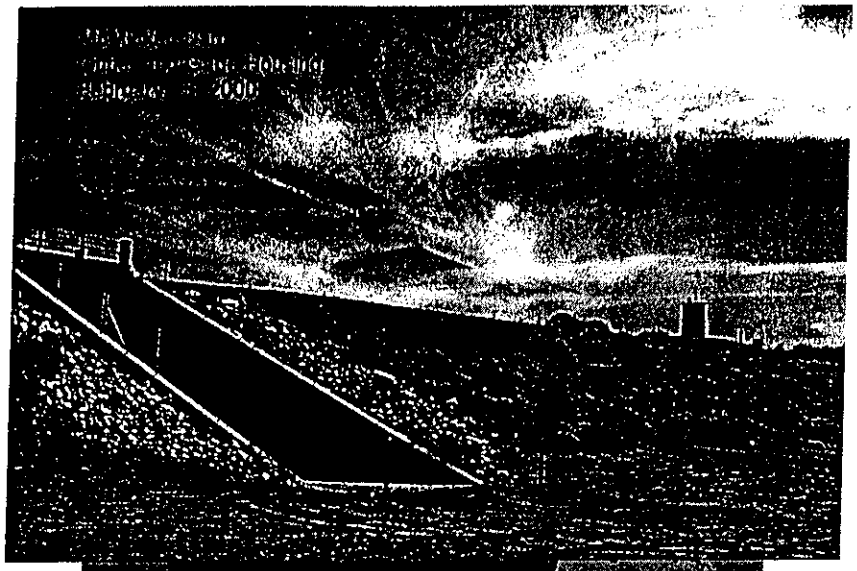
CREST GAGE NUMBER	PIN ELEVATION (FEET, GAGE HEIGHT)	CREST GAGE NUMBER	PIN ELEVATION (FEET, GAGE HEIGHT)
1	0.97	2	4.86

STAFF GAGE INFORMATION

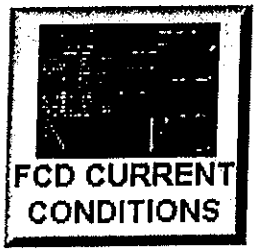
STAFF GAGE RANGE	LOW POINT	STAFF GAGE INFORMATION
0 - 7	0.00	
7 - 13	7.00	

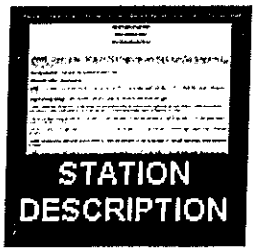
Page last updated on December 9, 2002

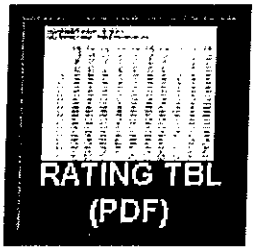
STATION: McMicken Dam GAGE ID: 5448

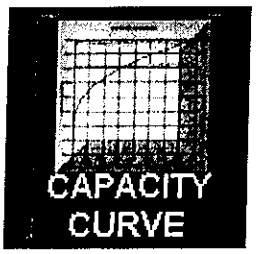


HOVER CURSOR OVER PHOTOS AND ICONS FOR DESCRIPTION AND SELECT ANY FOR FURTHER INFORMATION

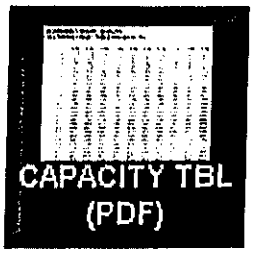


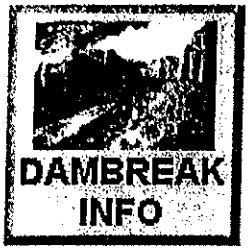






Maricopa County Flood Control District Gage Information, www.fcd.maricopa.gov/services/ALERT, May 2003





GAGE ID HISTORY | SITE DATA | RATING IN BRIEF | WATER YEAR PEAKS | IMPOUND HISTORY | STAFF GAGES

Station is located in the city of Surprise, near Grand Avenue (US 60) and 163rd Avenue.

GAGE ID HISTORY

ID	Elev of Instr. in GH	Elev of Instr. in MSL	Period
5448	0.00	1,332.02	6/15/92 - present
1603	0.00	1,332.02	10/1/87 - 6/15/92
47	Unknown	Unknown	3/20/83 - 10/1/87

SITE DATA

DRAINAGE AREA	247 MI^2
JURISDICTION	SURPRISE, ARIZONA
WATERSHED	TRILBY
SECTION/TOWNSHIP/RANGE	SW1/4 SW1/4 NW1/4 S24 T4N R2W
LATITUDE	N 33 40 38
LONGITUDE	W 112 25 23
USGS QUAD MAP	McMICKEN DAM 7.5-MINUTE
INSTALLATION DATE	MARCH 20, 1983
LENGTH OF RECORD (AS OF 10/01/02)	19.53 YEARS

Maricopa County Flood Control District Gage Information, www.fcd.maricopa.gov/services/ALERT, May 2008

STAGE GAGE TYPE	PRESSURE TRANSDUCER
STAFF GAGE	THREE
CREST STAGE GAGE	NONE
ZERO GAGE HEIGHT ELEVATION	1,332.02 FEET M.S.L.
STAGE GAGE ELEVATION	0.00 FEET GAGE HEIGHT
POINT OF ZERO FLOW	1.68 FEET GAGE HEIGHT
SPILLWAY CREST ELEVATION	21.1 FEET GAGE HEIGHT
TOP OF DAM ELEVATION	29.0 FEET GAGE HEIGHT

RATING INFORMATION

RATING TABLE

DISCHARGE RATING NUMBER 2, APPLIED AS OF MARCH 24, 1983

CAPACITY RATING NUMBER 2, APPLIED AS OF OCTOBER 1, 1994

(FLOW BEGINS AT ABOUT 1.7 FEET GAGE HEIGHT)

(ABOUT 100 ACRE-FEET OF STORAGE OCCURS BEFORE DETECTION BY THE GAGE)

GAGE HEIGHT (FEET)	ELEVATION (FEET NGVD 29)	DISCHARGE (CFS)	VOLUME (ACRE-FEET)
0.0	1,332.56	0	0
1.0	1,333.56	0	249
1.7	1,334.26	0	356
2.0	1,334.56	10	402
5.0	1,337.56	351	1,351
7.0	1,339.56	711	2,041
10.0	1,342.56	1,390	4,012
12.0	1,344.56	1,780	5,436
15.0	1,347.56	2,480	9,216
20.0	1,352.56	3,387	17,917

Maricopa County Flood Control District Gage Information, www.fcd.maricopa.gov/services/ALERT, May 2008

21.1	1,353.66	3,600	20,070
23.0	1,355.56	19,100	24,500
25.0	1,357.56	no data	29,608
27.0	1,359.56	no data	35,202

WATER YEAR PEAKS

WATER YEAR	EVENT DATE	PEAK WATER LEVEL (FEET GH)	PEAK VOLUME (ACRE-FEET)
2003			
2002	9/8/02	0.60	188
2001	10/27/00	0.60	188
2000	---	---	0
1999	---	---	0
1998	---	---	0
1997	---	---	0
1996	---	---	0
1995	---	---	0
1994	---	---	0
1993	1/11/93	3.60	868
1992	9/20/92	3.20	730
1991	10/1/90	2.80	592
1990	9/4/90	4.90	1,316
1989	8/15/89	0.70	203
1988	8/21/88	3.70	902
1987	No data available	No data available	No data available
1986	No data available	No data available	No data available

1985	No data available	No data available	No data available
1984	No data available	No data available	No data available
1983	No data available	No data available	No data available

IMPOUNDMENT HISTORY

ANNUAL REPORT MEAN DAILY STAGE

ANNUAL REPORT MEAN DAILY VOL.

(All events occurred over multiple days)

PEAK DATE	PEAK STAGE (FEET, G.H.)	PEAK VOLUME (ACRE-FEET)	WATER YEAR
9/11/02	0.55	180	2002
9/8/02	0.60	188	2002
10/27/00	0.60	188	2001
2/9/93	1.40	310	1993
1/19/93	2.80	592	1993
1/11/93	3.60	868	1993
9/24/92	2.20	387	1992
9/20/92	3.20	730	1992
8/26/92	0.70	203	1992
8/7/92	0.20	127	1992
7/30/92	0.10	111	1992
7/24/92	0.30	142	1992
3/15/92	0.10	111	1992
2/2/92	0.70	203	1992
1/27/92	0.90	234	1992

1/6/92	2.40	463	1992
11/7/91	0.80	218	1992
3/28/91	1.30	295	1991
2/28/91	0.70	203	1991
10/1/90	2.80	592	1991
9/4/90	4.90	1,316	1990
8/15/89	0.70	203	1989
8/24/88	2.10	417	1988
8/21/88	3.70	902	1988

STAFF GAGE INFORMATION

STAFF GAGE RANGE	STAFF GAGE INFORMATION
1338 - 1346 (MSL)	SUBTRACT 1,333.88 FEET TO GET GAGE HEIGHT
1346 - 1354 (MSL)	SUBTRACT 1,333.71 FEET TO GET GAGE HEIGHT
1354 - 1362 (MSL)	SUBTRACT 1,333.48 FEET TO GET GAGE HEIGHT
NOTES:	STAFF GAGES IN MAIN OUTLET READS DEPTH IN THE OUTLET ONLY AND ARE NOT RELATED TO GAGE HEIGHT M.S.L. DATUM IS EQUIVALENT TO NGVD 1929 DATUM

Page last updated on May 21, 2003

D.2. Physical Parameter Calculations

D.2.1. Soils

D.2.2. Land Use

D.2.3. Time of Concentration

D.2.4. Hydraulic Length and Slope

D.2.5. S-Graphs

D.2.1. Soils

Soil Type Summary

Yavapai Soil Parameter Estimation

APPENDIX D.2.1: Soil Type Summary

Entellus

SHEET		OF	
BY		DATE	4/19/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
AF800	0.7163	645110	110	49.04%	0.3513	0.13	0
AF800	0.7163	645112	112	3.18%	0.0228	0.39	0
AF800	0.7163	64553	53	14.01%	0.1004	0.02	0
AF800	0.7163	64568	68	2.23%	0.0160	0.63	0
AF800	0.7163	64577	77	2.23%	0.0160	0.05	0
AF800	0.7163	64598	98	16.24%	0.1163	0.37	0
AF800	0.7163	651285026	EPD	7.96%	0.0570	0.12	0
AF800	0.7163	651326426	GWD	0.96%	0.0069	0.35	0
AF800	0.7163	6514462	MV	0.96%	0.0069	0.15	0
AF800	0.7163	6516229	Ve	3.18%	0.0228	0.25	0
AF802	0.3902	651285026	EPD	4.14%	0.0162	0.12	0
AF802	0.3902	651326426	GWD	18.93%	0.0739	0.35	0
AF802	0.3902	6514462	MV	33.73%	0.1316	0.15	0
AF802	0.3902	651505422	PRB	8.88%	0.0346	0.28	0
AF802	0.3902	6515058	PT	4.14%	0.0162	0.40	0
AF802	0.3902	651585624	TSC	13.02%	0.0508	0.14	0
AF802	0.3902	6516229	Ve	17.16%	0.0670	0.25	0
AF803	2.8368	6512021	Aa	0.08%	0.0023	0.26	0
AF803	2.8368	651202320	AbA	0.49%	0.0139	0.38	0
AF803	2.8368	651202322	AbB	0.08%	0.0023	0.39	0
AF803	2.8368	651202720	AdA	1.87%	0.0530	0.40	0
AF803	2.8368	651202722	AdB	1.79%	0.0508	0.40	0
AF803	2.8368	651203222	AGB	4.63%	0.1313	0.40	0
AF803	2.8368	651203424	AHC	0.24%	0.0068	0.38	0
AF803	2.8368	6512857	Es	5.76%	0.1634	0.25	0
AF803	2.8368	651323320	GgA	8.60%	0.2440	0.25	0
AF803	2.8368	6513244	GM	32.79%	0.9302	0.29	0
AF803	2.8368	651326426	GWD	1.46%	0.0414	0.35	0
AF803	2.8368	651326826	GYD	1.87%	0.0530	0.26	0
AF803	2.8368	651422520	LcA	1.87%	0.0530	0.25	0
AF803	2.8368	6514451	Mp	5.36%	0.1521	0.25	0
AF803	2.8368	651445822	MTB	13.64%	0.3869	0.15	0
AF803	2.8368	6514462	MV	6.09%	0.1728	0.15	0
AF803	2.8368	6515833	Tg	0.08%	0.0023	0.04	0
AF803	2.8368	6515835	Th	2.76%	0.0783	0.04	0
AF803	2.8368	651585022	TPB	6.01%	0.1705	0.12	0
AF803	2.8368	651585520	TrA	0.24%	0.0068	0.11	0
AF803	2.8368	651585522	TrB	1.38%	0.0391	0.13	0
AF803	2.8368	651585624	TSC	1.46%	0.0414	0.14	0
AF803	2.8368	6516221	Va	0.57%	0.0162	0.39	0
AF803	2.8368	6516225	Vc	0.89%	0.0252	0.39	0
AF805	0.6276	651203424	AHC	13.53%	0.0849	0.38	0
AF805	0.6276	6513244	GM	13.16%	0.0826	0.29	0
AF805	0.6276	651422520	LcA	0.75%	0.0047	0.25	0
AF805	0.6276	651445822	MTB	24.81%	0.1557	0.15	0
AF805	0.6276	6514462	MV	47.74%	0.2996	0.15	0
AF807	1.0224	6512021	Aa	4.62%	0.0472	0.26	0
AF807	1.0224	6512451	Cp	0.24%	0.0025	0.40	0

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JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
AF807	1.0224	651323320	GgA	0.73%	0.0075	0.25	0
AF807	1.0224	6513244	GM	1.95%	0.0199	0.29	0
AF807	1.0224	6514223	Lb	4.38%	0.0448	0.40	0
AF807	1.0224	651422520	LcA	16.55%	0.1692	0.25	0
AF807	1.0224	6514229	Le	7.54%	0.0771	0.04	0
AF807	1.0224	6514451	Mp	12.41%	0.1269	0.25	0
AF807	1.0224	6514455	Mr	35.77%	0.3657	0.05	0
AF807	1.0224	651445822	MTB	0.73%	0.0075	0.15	0
AF807	1.0224	6514462	MV	0.24%	0.0025	0.15	0
AF807	1.0224	651502920	PeA	2.68%	0.0274	0.37	0
AF807	1.0224	651583120	TfA	0.24%	0.0025	0.37	0
AF807	1.0224	651583122	TfB	4.38%	0.0448	0.36	0
AF807	1.0224	6515833	Tg	0.49%	0.0050	0.04	0
AF807	1.0224	6515835	Th	6.08%	0.0622	0.04	0
AF807	1.0224	65164	W	0.97%	0.0099	0.00	0
AF810	2.1166	6512021	Aa	0.75%	0.0159	0.26	0
AF810	2.1166	651203222	AGB	0.64%	0.0135	0.40	0
AF810	2.1166	6512228	BE	9.16%	0.1939	0.24	0
AF810	2.1166	6513244	GM	5.11%	0.1082	0.29	0
AF810	2.1166	651326426	GWD	25.35%	0.5366	0.35	0
AF810	2.1166	651326826	GYD	0.32%	0.0068	0.26	0
AF810	2.1166	651422520	LcA	2.45%	0.0519	0.25	0
AF810	2.1166	6514451	Mp	2.24%	0.0474	0.25	0
AF810	2.1166	651445822	MTB	1.06%	0.0224	0.15	0
AF810	2.1166	6514462	MV	4.79%	0.1014	0.15	0
AF810	2.1166	651505422	PRB	6.92%	0.1465	0.28	0
AF810	2.1166	6515058	PT	9.27%	0.1962	0.40	0
AF810	2.1166	651506422	PWB	29.71%	0.6288	0.38	0
AF810	2.1166	651585624	TSC	0.64%	0.0135	0.14	0
AF810	2.1166	6516229	Ve	1.60%	0.0339	0.25	0
AF820	0.6957	651203222	AGB	12.94%	0.0900	0.40	0
AF820	0.6957	65124202	CA2	0.97%	0.0067	0.38	0
AF820	0.6957	6512423	Cb	1.94%	0.0135	0.40	0
AF820	0.6957	651445822	MTB	3.56%	0.0248	0.15	0
AF820	0.6957	651505422	PRB	1.94%	0.0135	0.28	0
AF820	0.6957	651506422	PWB	69.26%	0.4818	0.38	0
AF820	0.6957	651506826	PYD	0.32%	0.0022	0.20	0
AF820	0.6957	651545128	RpE	1.29%	0.0090	0.29	0
AF820	0.6957	6515826	TD	1.94%	0.0135	1.20	0
AF820	0.6957	651583120	TfA	1.29%	0.0090	0.37	0
AF820	0.6957	651585522	TrB	4.53%	0.0315	0.13	0
AF830	0.2663	65124202	CA2	1.96%	0.0052	0.38	0
AF830	0.2663	651422520	LcA	5.88%	0.0157	0.25	0
AF830	0.2663	651506422	PWB	11.76%	0.0313	0.38	0
AF830	0.2663	651545128	RpE	4.90%	0.0130	0.29	0
AF830	0.2663	6515829	Te	6.86%	0.0183	0.25	0
AF830	0.2663	651583120	TfA	4.90%	0.0130	0.37	0
AF830	0.2663	6515835	Th	14.71%	0.0392	0.04	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
AF830	0.2663	651585522	TrB	35.29%	0.0940	0.13	0
AF830	0.2663	6516231	Vf	13.73%	0.0366	0.01	0
AF850	0.2178	6512021	Aa	5.00%	0.0109	0.26	0
AF850	0.2178	6512423	Cb	3.00%	0.0065	0.40	0
AF850	0.2178	651323320	GgA	1.00%	0.0022	0.25	0
AF850	0.2178	6514451	Mp	1.00%	0.0022	0.25	0
AF850	0.2178	6515826	TD	3.00%	0.0065	1.20	0
AF850	0.2178	6515835	Th	28.00%	0.0610	0.04	0
AF850	0.2178	651585522	TrB	37.00%	0.0806	0.13	0
AF850	0.2178	6516231	Vf	22.00%	0.0479	0.01	0
AF852	0.1678	6512021	Aa	1.96%	0.0033	0.26	0
AF852	0.1678	6514451	Mp	11.76%	0.0197	0.25	0
AF852	0.1678	6515826	TD	7.84%	0.0132	1.20	0
AF852	0.1678	651583122	TfB	7.84%	0.0132	0.36	0
AF852	0.1678	6515835	Th	13.73%	0.0230	0.04	0
AF852	0.1678	651585522	TrB	45.10%	0.0757	0.13	0
AF852	0.1678	6516231	Vf	11.76%	0.0197	0.01	0
AF854	0.3382	6512857	Es	3.33%	0.0113	0.25	0
AF854	0.3382	651325036	GPI	2.50%	0.0085	0.00	0
AF854	0.3382	651326722	GxB	4.17%	0.0141	0.24	0
AF854	0.3382	651422520	LcA	20.83%	0.0704	0.25	0
AF854	0.3382	6514421	Ma	15.00%	0.0507	0.40	0
AF854	0.3382	6514451	Mp	8.33%	0.0282	0.25	0
AF854	0.3382	6514455	Mr	10.00%	0.0338	0.05	0
AF854	0.3382	6515826	TD	5.83%	0.0197	1.20	0
AF854	0.3382	6515829	Te	12.50%	0.0423	0.25	0
AF854	0.3382	651585522	TrB	17.50%	0.0592	0.13	0
AF860	0.3627	6512255	Br	1.32%	0.0048	1.05	0
AF860	0.3627	6512857	Es	16.45%	0.0597	0.25	0
AF860	0.3627	651323320	GgA	14.47%	0.0525	0.25	0
AF860	0.3627	651326720	GWD	0.66%	0.0024	0.35	0
AF860	0.3627	651422520	LcA	0.66%	0.0024	0.25	0
AF860	0.3627	6514421	Ma	9.87%	0.0358	0.40	0
AF860	0.3627	6514451	Mp	3.95%	0.0143	0.25	0
AF860	0.3627	651542320	RbA	2.63%	0.0095	0.26	0
AF860	0.3627	6515826	TD	11.18%	0.0405	1.20	0
AF860	0.3627	651585522	TrB	4.61%	0.0167	0.13	0
AF860	0.3627	6516233	Vg	21.71%	0.0787	0.91	0
AF860	0.3627	6516235	Vh	12.50%	0.0453	0.27	0
AF862	0.1772	6512255	Br	1.43%	0.0025	1.05	0
AF862	0.1772	6512857	Es	4.29%	0.0076	0.25	0
AF862	0.1772	651323320	GgA	22.86%	0.0405	0.25	0
AF862	0.1772	6514421	Ma	4.29%	0.0076	0.40	0
AF862	0.1772	6514451	Mp	1.43%	0.0025	0.25	0
AF862	0.1772	6516233	Vg	28.57%	0.0506	0.91	0
AF862	0.1772	6516235	Vh	37.14%	0.0658	0.27	0
AF864	0.0868	651323320	GgA	12.50%	0.0109	0.25	0
AF864	0.0868	6514451	Mp	37.50%	0.0326	0.25	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
AF864	0.0868	651585522	TrB	50.00%	0.0434	0.13	0
AF866	0.4549	6512857	Es	2.60%	0.0118	0.25	0
AF866	0.4549	651326720	GWD	1.56%	0.0071	0.35	0
AF866	0.4549	651326722	GxB	0.52%	0.0024	0.24	0
AF866	0.4549	651422520	LcA	5.73%	0.0261	0.25	0
AF866	0.4549	6514451	Mp	27.08%	0.1232	0.25	0
AF866	0.4549	6514455	Mr	34.90%	0.1588	0.05	0
AF866	0.4549	651542320	RbA	7.29%	0.0332	0.26	0
AF866	0.4549	651583120	TfA	2.60%	0.0118	0.37	0
AF866	0.4549	651585522	TrB	17.71%	0.0806	0.13	0
IW300	1.4800	6451	1	1.23%	0.0182	0.41	0
IW300	1.4800	645112	112	33.38%	0.4940	0.39	0
IW300	1.4800	64522	22	16.08%	0.2380	0.04	0
IW300	1.4800	6453	3	12.40%	0.1835	0.58	0
IW300	1.4800	64553	53	11.64%	0.1723	0.02	0
IW300	1.4800	64555	55	12.25%	0.1813	0.27	0
IW300	1.4800	64576	76	13.02%	0.1927	0.23	0
IW302	1.3264	645112	112	41.71%	0.5532	0.39	0
IW302	1.3264	645113	113	14.87%	0.1972	0.39	0
IW302	1.3264	64522	22	7.69%	0.1020	0.04	0
IW302	1.3264	6453	3	11.11%	0.1474	0.58	0
IW302	1.3264	64553	53	11.79%	0.1564	0.02	0
IW302	1.3264	64555	55	1.54%	0.0204	0.27	0
IW302	1.3264	64598	98	11.28%	0.1496	0.37	0
IW310	1.1672	645112	112	4.22%	0.0493	0.39	0
IW310	1.1672	64522	22	40.12%	0.4683	0.04	0
IW310	1.1672	64553	53	23.03%	0.2688	0.02	0
IW310	1.1672	64576	76	32.63%	0.3808	0.23	0
IW312	0.5682	64546	46	86.00%	0.4887	0.03	0
IW312	0.5682	64574	74	14.00%	0.0795	0.08	0
IW314	2.1754	645112	112	32.82%	0.7140	0.39	0
IW314	2.1754	6452	2	1.86%	0.0405	0.41	0
IW314	2.1754	64522	22	16.67%	0.3626	0.04	0
IW314	2.1754	64553	53	14.70%	0.3198	0.02	0
IW314	2.1754	64555	55	8.07%	0.1756	0.27	0
IW314	2.1754	64560	60	0.72%	0.0157	0.26	0
IW314	2.1754	64570	70	16.15%	0.3513	0.36	0
IW314	2.1754	64576	76	4.87%	0.1059	0.23	0
IW314	2.1754	64578	78	4.14%	0.0901	0.05	0
IW318	0.5832	645112	112	24.51%	0.1429	0.39	0
IW318	0.5832	64522	22	41.11%	0.2397	0.04	0
IW318	0.5832	64553	53	34.39%	0.2005	0.02	0
IW322	1.8923	645112	112	3.60%	0.0681	0.39	0
IW322	1.8923	64522	22	50.30%	0.9518	0.04	0
IW322	1.8923	64553	53	20.65%	0.3907	0.02	0
IW322	1.8923	64558	58	0.84%	0.0159	0.34	0
IW322	1.8923	64560	60	2.28%	0.0431	0.26	0
IW322	1.8923	64570	70	8.76%	0.1658	0.36	0

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Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
IW322	1.8923	64576	76	5.64%	0.1067	0.23	0
IW322	1.8923	64577	77	5.16%	0.0976	0.05	0
IW322	1.8923	64578	78	2.76%	0.0522	0.05	0
IW326	0.3331	645112	112	14.69%	0.0489	0.39	0
IW326	0.3331	64558	58	13.99%	0.0466	0.34	0
IW326	0.3331	64576	76	51.05%	0.1700	0.23	0
IW326	0.3331	64578	78	20.28%	0.0675	0.05	0
IW330	1.0372	64529	29	12.36%	0.1282	0.34	0
IW330	1.0372	64553	53	12.80%	0.1328	0.02	0
IW330	1.0372	64555	55	16.05%	0.1665	0.27	0
IW330	1.0372	64558	58	36.44%	0.3779	0.34	0
IW330	1.0372	64570	70	6.29%	0.0652	0.36	0
IW330	1.0372	64576	76	0.65%	0.0067	0.23	0
IW330	1.0372	64578	78	15.40%	0.1597	0.05	0
IW334	1.2571	645112	112	21.30%	0.2678	0.39	0
IW334	1.2571	64522	22	8.48%	0.1066	0.04	0
IW334	1.2571	64553	53	7.22%	0.0908	0.02	0
IW334	1.2571	64576	76	3.61%	0.0454	0.23	0
IW334	1.2571	64578	78	21.30%	0.2678	0.05	0
IW334	1.2571	64598	98	38.09%	0.4788	0.37	0
IW338	0.3390	645112	112	20.98%	0.0711	0.39	0
IW338	0.3390	64522	22	5.59%	0.0190	0.04	0
IW338	0.3390	64576	76	3.50%	0.0119	0.23	0
IW338	0.3390	64580	80	45.45%	0.1541	0.08	0
IW338	0.3390	64598	98	24.48%	0.0830	0.37	0
IW342	0.3535	645112	112	17.11%	0.0605	0.39	0
IW342	0.3535	64558	58	30.92%	0.1093	0.34	0
IW342	0.3535	64580	80	16.45%	0.0582	0.08	0
IW342	0.3535	64598	98	35.53%	0.1256	0.37	0
IW346	3.4432	645112	112	3.25%	0.1119	0.39	0
IW346	3.4432	64522	22	9.88%	0.3402	0.04	0
IW346	3.4432	64523	23	2.93%	0.1009	0.01	0
IW346	3.4432	64529	29	6.63%	0.2283	0.34	0
IW346	3.4432	64555	55	15.41%	0.5306	0.27	0
IW346	3.4432	64558	58	54.16%	1.8648	0.34	0
IW346	3.4432	64570	70	5.01%	0.1725	0.36	0
IW346	3.4432	64576	76	0.07%	0.0024	0.23	0
IW346	3.4432	64578	78	2.60%	0.0895	0.05	0
IW346	3.4432	64598	98	0.07%	0.0024	0.37	0
IW349	0.2498	645113	113	76.15%	0.1902	0.39	0
IW349	0.2498	64548	48	23.85%	0.0596	0.06	0
IW350	2.1751	645110	110	27.21%	0.5918	0.13	0
IW350	2.1751	645119	119	2.80%	0.0609	0.14	0
IW350	2.1751	64522	22	36.14%	0.7861	0.04	0
IW350	2.1751	64529	29	7.17%	0.1560	0.34	0
IW350	2.1751	64553	53	0.42%	0.0091	0.02	0
IW350	2.1751	64555	55	2.49%	0.0542	0.27	0
IW350	2.1751	64570	70	10.49%	0.2282	0.36	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
IW350	2.1751	64575	75	13.29%	0.2891	0.23	0
IW351	0.3164	645113	113	2.17%	0.0069	0.39	0
IW351	0.3164	64546	46	5.80%	0.0183	0.03	0
IW351	0.3164	64558	58	20.29%	0.0642	0.34	0
IW351	0.3164	64598	98	71.74%	0.2270	0.37	0
IW352	0.0961	645113	113	48.84%	0.0469	0.39	0
IW352	0.0961	64548	48	11.63%	0.0112	0.06	0
IW352	0.0961	64558	58	37.21%	0.0357	0.34	0
IW352	0.0961	64598	98	2.33%	0.0022	0.37	0
IW353	2.8031	64521	21	1.12%	0.0314	0.38	0
IW353	2.8031	64522	22	50.20%	1.4072	0.04	0
IW353	2.8031	64529	29	23.38%	0.6554	0.34	0
IW353	2.8031	64544	44	4.32%	0.1211	0.03	0
IW353	2.8031	64546	46	10.41%	0.2918	0.03	0
IW353	2.8031	64553	53	0.16%	0.0045	0.02	0
IW353	2.8031	64555	55	0.16%	0.0045	0.27	0
IW353	2.8031	64558	58	6.89%	0.1931	0.34	0
IW353	2.8031	64575	75	2.64%	0.0740	0.23	0
IW353	2.8031	64598	98	0.72%	0.0202	0.37	0
IW354	0.3605	64548	48	92.90%	0.3349	0.06	0
IW354	0.3605	64558	58	7.10%	0.0256	0.34	0
IW356	0.2861	645113	113	24.03%	0.0688	0.39	0
IW356	0.2861	64548	48	75.97%	0.2174	0.06	0
IW357	0.7457	64522	22	0.30%	0.0022	0.04	0
IW357	0.7457	64529	29	3.03%	0.0226	0.34	0
IW357	0.7457	6453	3	4.24%	0.0316	0.58	0
IW357	0.7457	64546	46	63.64%	0.4746	0.03	0
IW357	0.7457	64574	74	6.36%	0.0474	0.08	0
IW357	0.7457	64598	98	22.42%	0.1672	0.37	0
IW358	0.1641	64522	22	7.58%	0.0124	0.04	0
IW358	0.1641	64529	29	12.12%	0.0199	0.34	0
IW358	0.1641	64555	55	25.76%	0.0423	0.27	0
IW358	0.1641	64558	58	54.55%	0.0895	0.34	0
IW359	2.9120	645110	110	2.01%	0.0585	0.13	0
IW359	2.9120	64521	21	1.47%	0.0428	0.38	0
IW359	2.9120	64522	22	0.93%	0.0271	0.04	0
IW359	2.9120	64529	29	45.91%	1.3369	0.34	0
IW359	2.9120	64544	44	6.48%	0.1887	0.03	0
IW359	2.9120	64553	53	19.52%	0.5684	0.02	0
IW359	2.9120	64555	55	15.20%	0.4426	0.27	0
IW359	2.9120	64575	75	4.71%	0.1372	0.23	0
IW359	2.9120	64598	98	3.78%	0.1101	0.37	0
IW360	0.8306	645113	113	29.05%	0.2413	0.39	0
IW360	0.8306	64558	58	3.63%	0.0302	0.34	0
IW360	0.8306	64598	98	67.32%	0.5592	0.37	0
IW361	0.3547	64522	22	2.58%	0.0092	0.04	0
IW361	0.3547	64529	29	7.10%	0.0252	0.34	0
IW361	0.3547	64544	44	17.42%	0.0618	0.03	0

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JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
IW361	0.3547	64546	46	12.90%	0.0458	0.03	0
IW361	0.3547	64555	55	20.65%	0.0733	0.27	0
IW361	0.3547	64558	58	39.35%	0.1396	0.34	0
IW362	0.1794	64548	48	75.00%	0.1345	0.06	0
IW362	0.1794	64558	58	25.00%	0.0448	0.34	0
IW363	0.6278	645113	113	0.36%	0.0023	0.39	0
IW363	0.6278	64546	46	78.55%	0.4931	0.03	0
IW363	0.6278	64574	74	10.18%	0.0639	0.08	0
IW363	0.6278	64598	98	10.91%	0.0685	0.37	0
IW364	1.1451	645113	113	1.38%	0.0158	0.39	0
IW364	1.1451	64544	44	82.45%	0.9441	0.03	0
IW364	1.1451	64548	48	14.40%	0.1649	0.06	0
IW364	1.1451	64580	80	1.58%	0.0181	0.08	0
IW364	1.1451	64598	98	0.20%	0.0023	0.37	0
IW365	0.4729	64546	46	100.00%	0.4729	0.03	0
IW366	1.0558	64529	29	23.01%	0.2429	0.34	0
IW366	1.0558	64544	44	4.95%	0.0523	0.03	0
IW366	1.0558	64547	47	0.22%	0.0023	0.11	0
IW366	1.0558	64553	53	17.63%	0.1861	0.02	0
IW366	1.0558	64575	75	1.29%	0.0136	0.23	0
IW366	1.0558	64577	77	7.10%	0.0750	0.05	0
IW366	1.0558	64598	98	45.81%	0.4837	0.37	0
IW367	0.0512	64546	46	100.00%	0.0512	0.03	0
IW368	0.2907	645113	113	100.00%	0.2907	0.39	0
IW369	0.7949	645113	113	6.86%	0.0545	0.39	0
IW369	0.7949	64546	46	93.14%	0.7404	0.03	0
IW370	0.8795	645113	113	57.11%	0.5023	0.39	0
IW370	0.8795	6453	3	25.58%	0.2250	0.58	0
IW370	0.8795	64546	46	17.31%	0.1522	0.03	0
IW371	0.0529	64598	98	100.00%	0.0529	0.37	0
IW372	0.3175	645113	113	78.57%	0.2495	0.39	0
IW372	0.3175	6453	3	0.71%	0.0023	0.58	0
IW372	0.3175	64544	44	20.71%	0.0658	0.03	0
IW374	0.3875	64544	44	68.42%	0.2651	0.03	0
IW374	0.3875	64598	98	31.58%	0.1224	0.37	0
IW375	0.6582	645113	113	46.48%	0.3059	0.39	0
IW375	0.6582	64544	44	53.52%	0.3523	0.03	0
IW377	0.1126	645110	110	38.10%	0.0429	0.13	0
IW377	0.1126	64544	44	19.05%	0.0214	0.03	0
IW377	0.1126	64598	98	42.86%	0.0482	0.37	0
IW380	0.4998	6453	3	12.56%	0.0628	0.58	0
IW380	0.4998	64535	35	15.35%	0.0767	0.23	0
IW380	0.4998	64539	39	4.65%	0.0232	0.29	0
IW380	0.4998	64544	44	43.26%	0.2162	0.03	0
IW380	0.4998	64546	46	11.63%	0.0581	0.03	0
IW380	0.4998	64548	48	0.93%	0.0046	0.06	0
IW380	0.4998	6457	7	11.63%	0.0581	0.62	0
IW381	0.3841	64529	29	14.12%	0.0542	0.34	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
IW381	0.3841	64544	44	77.06%	0.2960	0.03	0
IW381	0.3841	64574	74	8.82%	0.0339	0.08	0
IW382	0.6196	64513	13	1.82%	0.0113	0.01	0
IW382	0.6196	64529	29	54.74%	0.3392	0.34	0
IW382	0.6196	64544	44	33.94%	0.2103	0.03	0
IW382	0.6196	64574	74	3.28%	0.0203	0.08	0
IW382	0.6196	64598	98	6.20%	0.0384	0.37	0
IW384	0.0826	64529	29	23.53%	0.0194	0.34	0
IW384	0.0826	64544	44	76.47%	0.0631	0.03	0
IW386	0.3732	645110	110	7.41%	0.0277	0.13	0
IW386	0.3732	64513	13	3.09%	0.0115	0.01	0
IW386	0.3732	64544	44	33.95%	0.1267	0.03	0
IW386	0.3732	64548	48	28.40%	0.1060	0.06	0
IW386	0.3732	64549	49	14.20%	0.0530	0.06	0
IW386	0.3732	64574	74	1.23%	0.0046	0.08	0
IW386	0.3732	64598	98	11.73%	0.0438	0.37	0
IW387	1.3509	64536	36	32.72%	0.4420	0.07	0
IW387	1.3509	64539	39	43.85%	0.5924	0.29	0
IW387	1.3509	64564	64	9.80%	0.1324	0.14	25
IW387	1.3509	6457	7	1.66%	0.0224	0.62	0
IW387	1.3509	64594	94	11.96%	0.1616	0.33	0
IW388	1.2257	64513	13	3.49%	0.0428	0.01	0
IW388	1.2257	64529	29	8.26%	0.1012	0.34	0
IW388	1.2257	6453	3	9.54%	0.1169	0.58	0
IW388	1.2257	64544	44	13.39%	0.1641	0.03	0
IW388	1.2257	64546	46	62.20%	0.7624	0.03	0
IW388	1.2257	64598	98	3.12%	0.0382	0.37	0
IW389	0.1312	64546	46	100.00%	0.1312	0.03	0
IW390	0.3110	645110	110	14.60%	0.0454	0.13	0
IW390	0.3110	6453	3	29.20%	0.0908	0.58	0
IW390	0.3110	64544	44	0.73%	0.0023	0.03	0
IW390	0.3110	64548	48	12.41%	0.0386	0.06	0
IW390	0.3110	64549	49	8.76%	0.0272	0.06	0
IW390	0.3110	64574	74	5.84%	0.0182	0.08	0
IW390	0.3110	64598	98	28.47%	0.0885	0.37	0
IW390A	0.9003	64513	13	1.52%	0.0137	0.01	0
IW390A	0.9003	64528	28	5.56%	0.0501	0.02	0
IW390A	0.9003	6453	3	5.81%	0.0523	0.58	0
IW390A	0.9003	64542	42	5.05%	0.0455	0.17	0
IW390A	0.9003	64548	48	2.78%	0.0250	0.06	0
IW390A	0.9003	64564	64	16.16%	0.1455	0.14	25
IW390A	0.9003	64566	66	3.28%	0.0295	0.23	0
IW390A	0.9003	64568	68	3.03%	0.0273	0.63	0
IW390A	0.9003	64573	73	28.03%	0.2524	0.09	30
IW390A	0.9003	64574	74	5.81%	0.0523	0.08	0
IW390A	0.9003	64594	94	22.98%	0.2069	0.33	0
IW392	1.1135	6453	3	2.65%	0.0295	0.58	0
IW392	1.1135	64546	46	28.98%	0.3227	0.03	0

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Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
IW392	1.1135	64548	48	31.84%	0.3546	0.06	0
IW392	1.1135	64564	64	13.27%	0.1478	0.14	25
IW392	1.1135	64574	74	3.27%	0.0364	0.08	0
IW392	1.1135	64598	98	20.00%	0.2227	0.37	0
IW394	4.1731	645121	121	4.74%	0.1978	0.12	0
IW394	4.1731	64531	31	5.11%	0.2132	0.33	35
IW394	4.1731	64533	33	9.20%	0.3839	0.23	0
IW394	4.1731	64536	36	15.45%	0.6448	0.07	0
IW394	4.1731	64539	39	2.91%	0.1214	0.29	0
IW394	4.1731	64542	42	7.00%	0.2921	0.17	0
IW394	4.1731	64563	63	37.30%	1.5566	0.14	25
IW394	4.1731	64566	66	3.34%	0.1394	0.23	0
IW394	4.1731	6457	7	1.18%	0.0492	0.62	0
IW394	4.1731	64573	73	11.52%	0.4807	0.09	30
IW394	4.1731	64594	94	2.26%	0.0943	0.33	0
IW395	7.8618	637244526	CmD	3.37%	0.2649	0.00	0
IW395	7.8618	6374229	Le	5.23%	0.4112	0.00	0
IW395	7.8618	6374235	Lh	1.14%	0.0896	0.00	0
IW395	7.8618	6375455	Rr	3.26%	0.2563	0.00	0
IW395	7.8618	645104	104	1.23%	0.0967	0.14	60
IW395	7.8618	64516	16	0.23%	0.0181	0.44	15
IW395	7.8618	64531	31	3.49%	0.2744	0.33	35
IW395	7.8618	64534	34	5.12%	0.4025	0.23	0
IW395	7.8618	64536	36	1.40%	0.1101	0.07	0
IW395	7.8618	64543	43	1.06%	0.0833	0.17	0
IW395	7.8618	64562	62	0.17%	0.0134	0.15	0
IW395	7.8618	64563	63	65.28%	5.1322	0.14	25
IW395	7.8618	6457	7	1.20%	0.0943	0.62	0
IW395	7.8618	64572	72	7.01%	0.5511	0.09	30
IW395	7.8618	64597	97	0.80%	0.0629	0.07	0
IW396	0.5863	64535	35	26.54%	0.1556	0.23	0
IW396	0.5863	64536	36	12.69%	0.0744	0.07	0
IW396	0.5863	64539	39	13.85%	0.0812	0.29	0
IW396	0.5863	64543	43	5.38%	0.0315	0.17	0
IW396	0.5863	64544	44	0.38%	0.0022	0.03	0
IW396	0.5863	64564	64	0.77%	0.0045	0.14	25
IW396	0.5863	6457	7	40.38%	0.2367	0.62	0
IW397	4.8148	637244526	CmD	44.82%	2.1580	0.00	0
IW397	4.8148	637244730	CnF	0.28%	0.0135	0.00	0
IW397	4.8148	6374229	Le	16.65%	0.8017	0.00	0
IW397	4.8148	6374235	Lh	16.60%	0.7993	0.00	0
IW397	4.8148	6375455	Rr	21.64%	1.0419	0.00	0
PD700	1.3998	651203222	AGB	1.63%	0.0228	0.40	0
PD700	1.3998	651203424	AHC	10.60%	0.1484	0.38	0
PD700	1.3998	6513244	GM	18.27%	0.2557	0.29	0
PD700	1.3998	651326426	GWD	2.77%	0.0388	0.35	0
PD700	1.3998	651326826	GYD	12.72%	0.1780	0.26	0
PD700	1.3998	651445822	MTB	26.59%	0.3722	0.15	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PD700	1.3998	6514462	MV	16.97%	0.2375	0.15	0
PD700	1.3998	651505422	PRB	0.33%	0.0046	0.28	0
PD700	1.3998	651585022	TPB	4.89%	0.0684	0.12	0
PD700	1.3998	651585624	TSC	5.22%	0.0731	0.14	0
PD704	0.3620	645110	110	17.20%	0.0623	0.13	0
PD704	0.3620	64568	68	7.64%	0.0277	0.63	0
PD704	0.3620	64570	70	11.46%	0.0415	0.36	0
PD704	0.3620	64598	98	38.85%	0.1406	0.37	0
PD704	0.3620	651326426	GWD	15.29%	0.0553	0.35	0
PD704	0.3620	651326826	GYD	2.55%	0.0092	0.26	0
PD704	0.3620	651505422	PRB	6.37%	0.0231	0.28	0
PD704	0.3620	651585624	TSC	0.64%	0.0023	0.14	0
PD708	2.4019	64510	10	4.57%	0.1098	0.94	0
PD708	2.4019	645100	100	22.29%	0.5354	0.40	20
PD708	2.4019	645108	108	0.65%	0.0156	0.31	30
PD708	2.4019	645110	110	42.63%	1.0239	0.13	0
PD708	2.4019	645113	113	2.05%	0.0492	0.39	0
PD708	2.4019	64518	18	3.64%	0.0874	0.33	15
PD708	2.4019	64547	47	6.34%	0.1523	0.11	0
PD708	2.4019	64552	52	0.19%	0.0046	0.16	20
PD708	2.4019	64568	68	0.19%	0.0046	0.63	0
PD708	2.4019	64598	98	13.53%	0.3250	0.37	0
PD708	2.4019	651326426	GWD	3.92%	0.0942	0.35	0
PD712	0.8916	645110	110	7.09%	0.0632	0.13	0
PD712	0.8916	64552	52	68.61%	0.6117	0.16	20
PD712	0.8916	64598	98	17.72%	0.1580	0.37	0
PD712	0.8916	651326426	GWD	6.58%	0.0587	0.35	0
PD712A	0.7664	64510	10	0.88%	0.0067	0.94	0
PD712A	0.7664	645100	100	3.24%	0.0248	0.40	20
PD712A	0.7664	645110	110	12.06%	0.0924	0.13	0
PD712A	0.7664	645113	113	7.06%	0.0541	0.39	0
PD712A	0.7664	64521	21	2.35%	0.0180	0.38	0
PD712A	0.7664	64552	52	46.76%	0.3584	0.16	20
PD712A	0.7664	64568	68	9.12%	0.0699	0.63	0
PD712A	0.7664	64598	98	15.59%	0.1195	0.37	0
PD712A	0.7664	651326426	GWD	2.94%	0.0225	0.35	0
PD716	1.7546	645103	103	1.80%	0.0316	0.10	65
PD716	1.7546	645118	118	0.64%	0.0112	0.42	0
PD716	1.7546	64548	48	1.29%	0.0226	0.06	0
PD716	1.7546	64552	52	16.62%	0.2916	0.16	20
PD716	1.7546	64598	98	0.77%	0.0135	0.37	0
PD716	1.7546	651203424	AHC	13.14%	0.2305	0.38	0
PD716	1.7546	651285026	EPD	1.03%	0.0181	0.12	0
PD716	1.7546	6513244	GM	4.90%	0.0860	0.29	0
PD716	1.7546	651326426	GWD	1.42%	0.0249	0.35	0
PD716	1.7546	651445822	MTB	28.74%	0.5043	0.15	0
PD716	1.7546	6514462	MV	4.64%	0.0814	0.15	0
PD716	1.7546	651505422	PRB	0.39%	0.0068	0.28	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PD716	1.7546	651506422	PWB	1.29%	0.0226	0.38	0
PD716	1.7546	651585022	TPB	21.52%	0.3776	0.12	0
PD716	1.7546	651585624	TSC	1.80%	0.0316	0.14	0
PD720	0.5945	6513244	GM	58.85%	0.3498	0.29	0
PD720	0.5945	651326426	GWD	3.46%	0.0206	0.35	0
PD720	0.5945	651445822	MTB	25.38%	0.1509	0.15	0
PD720	0.5945	6514462	MV	9.23%	0.0549	0.15	0
PD720	0.5945	651585022	TPB	3.08%	0.0183	0.12	0
PD726	0.4126	64555	55	9.14%	0.0377	0.27	0
PD726	0.4126	64558	58	3.23%	0.0133	0.34	0
PD726	0.4126	64598	98	23.12%	0.0954	0.37	0
PD726	0.4126	6512042	AL	8.60%	0.0355	0.40	0
PD726	0.4126	6513244	GM	46.24%	0.1908	0.29	0
PD726	0.4126	651445822	MTB	5.91%	0.0244	0.15	0
PD726	0.4126	6514462	MV	1.08%	0.0045	0.15	0
PD726	0.4126	651585022	TPB	2.69%	0.0111	0.12	0
PD726A	1.1030	645113	113	41.31%	0.4556	0.39	0
PD726A	1.1030	64521	21	4.29%	0.0473	0.38	0
PD726A	1.1030	64552	52	19.84%	0.2188	0.16	20
PD726A	1.1030	64555	55	13.09%	0.1444	0.27	0
PD726A	1.1030	64598	98	18.61%	0.2053	0.37	0
PD726A	1.1030	651445822	MTB	2.86%	0.0315	0.15	0
PD726B	0.9345	64552	52	9.00%	0.0841	0.16	20
PD726B	0.9345	64555	55	0.24%	0.0022	0.27	0
PD726B	0.9345	64558	58	15.40%	0.1439	0.34	0
PD726B	0.9345	64580	80	2.37%	0.0221	0.08	0
PD726B	0.9345	64598	98	72.99%	0.6821	0.37	0
PD732	0.4793	645110	110	42.18%	0.2022	0.13	0
PD732	0.4793	645113	113	19.43%	0.0931	0.39	0
PD732	0.4793	64555	55	4.27%	0.0205	0.27	0
PD732	0.4793	64598	98	34.12%	0.1635	0.37	0
PD736	0.7789	64552	52	1.46%	0.0114	0.16	20
PD736	0.7789	64555	55	5.54%	0.0432	0.27	0
PD736	0.7789	64580	80	17.78%	0.1385	0.08	0
PD736	0.7789	64598	98	75.22%	0.5859	0.37	0
PD740	1.2839	6452	2	5.73%	0.0736	0.41	0
PD740	1.2839	64552	52	4.30%	0.0552	0.16	20
PD740	1.2839	64558	58	6.09%	0.0782	0.34	0
PD740	1.2839	64570	70	27.24%	0.3497	0.36	0
PD740	1.2839	64598	98	56.63%	0.7271	0.37	0
PD744	0.7975	645115	115	0.28%	0.0022	0.39	0
PD744	0.7975	64552	52	1.98%	0.0158	0.16	20
PD744	0.7975	64558	58	6.78%	0.0541	0.34	0
PD744	0.7975	651203222	AGB	12.43%	0.0991	0.40	0
PD744	0.7975	651203424	AHC	8.47%	0.0676	0.38	0
PD744	0.7975	6512042	AL	25.99%	0.2073	0.40	0
PD744	0.7975	6513244	GM	34.18%	0.2726	0.29	0
PD744	0.7975	651445822	MTB	9.89%	0.0789	0.15	0

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PD748	0.2838	645100	100	5.65%	0.0160	0.40	20
PD748	0.2838	645109	109	76.61%	0.2174	0.35	35
PD748	0.2838	645110	110	15.32%	0.0435	0.13	0
PD748	0.2838	64547	47	2.42%	0.0069	0.11	0
PD752	0.1897	645100	100	44.05%	0.0836	0.40	20
PD752	0.1897	645108	108	7.14%	0.0135	0.31	30
PD752	0.1897	645109	109	48.81%	0.0926	0.35	35
PD756	3.2304	64510	10	2.65%	0.0856	0.94	0
PD756	3.2304	645108	108	13.16%	0.4251	0.31	30
PD756	3.2304	645109	109	66.64%	2.1528	0.35	35
PD756	3.2304	645110	110	1.53%	0.0494	0.13	0
PD756	3.2304	645113	113	0.63%	0.0204	0.39	0
PD756	3.2304	64521	21	1.53%	0.0494	0.38	0
PD756	3.2304	64547	47	0.42%	0.0136	0.11	0
PD756	3.2304	64549	49	1.04%	0.0336	0.06	0
PD756	3.2304	64552	52	0.49%	0.0158	0.16	20
PD756	3.2304	64555	55	0.28%	0.0090	0.27	0
PD756	3.2304	64598	98	11.63%	0.3757	0.37	0
PD760	0.8671	645109	109	17.49%	0.1516	0.35	35
PD760	0.8671	645110	110	47.52%	0.4120	0.13	0
PD760	0.8671	645113	113	26.89%	0.2332	0.39	0
PD760	0.8671	64598	98	8.09%	0.0701	0.37	0
PI600	0.6050	651203222	AGB	12.08%	0.0731	0.40	0
PI600	0.6050	6513244	GM	43.77%	0.2648	0.29	0
PI600	0.6050	651445822	MTB	36.60%	0.2214	0.15	0
PI600	0.6050	6514462	MV	7.55%	0.0457	0.15	0
PI600A	0.5203	651203222	AGB	13.74%	0.0715	0.40	0
PI600A	0.5203	6513244	GM	31.75%	0.1652	0.29	0
PI600A	0.5203	651445822	MTB	42.65%	0.2219	0.15	0
PI600A	0.5203	6514462	MV	11.85%	0.0617	0.15	0
PI603	0.5190	645115	115	2.17%	0.0113	0.39	0
PI603	0.5190	64558	58	7.39%	0.0384	0.34	0
PI603	0.5190	651203222	AGB	17.83%	0.0925	0.40	0
PI603	0.5190	651203424	AHC	18.26%	0.0948	0.38	0
PI603	0.5190	6513244	GM	24.78%	0.1286	0.29	0
PI603	0.5190	651445822	MTB	6.96%	0.0361	0.15	0
PI603	0.5190	6515456	RS	3.48%	0.0181	0.40	65
PI603	0.5190	651585022	TPB	19.13%	0.0993	0.12	0
PI604	0.3628	64518	18	3.80%	0.0138	0.33	15
PI604	0.3628	64552	52	51.27%	0.1860	0.16	20
PI604	0.3628	64558	58	27.22%	0.0988	0.34	0
PI604	0.3628	64598	98	11.39%	0.0413	0.37	0
PI604	0.3628	6512448	CO	1.90%	0.0069	0.29	20
PI604	0.3628	6513244	GM	1.27%	0.0046	0.29	0
PI604	0.3628	6515456	RS	3.16%	0.0115	0.40	65
PI606	1.0766	645115	115	2.52%	0.0271	0.39	0
PI606	1.0766	64518	18	1.05%	0.0113	0.33	15
PI606	1.0766	64552	52	0.21%	0.0023	0.16	20

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Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PI606	1.0766	64558	58	10.29%	0.1108	0.34	0
PI606	1.0766	64570	70	1.47%	0.0158	0.36	0
PI606	1.0766	64598	98	23.74%	0.2556	0.37	0
PI606	1.0766	651203222	AGB	0.84%	0.0090	0.40	0
PI606	1.0766	651203424	AHC	18.70%	0.2013	0.38	0
PI606	1.0766	6512448	CO	3.15%	0.0339	0.29	20
PI606	1.0766	6513244	GM	32.35%	0.3483	0.29	0
PI606	1.0766	651445822	MTB	2.73%	0.0294	0.15	0
PI606	1.0766	6514462	MV	2.10%	0.0226	0.15	0
PI606	1.0766	6515456	RS	0.84%	0.0090	0.40	65
PI606A	0.4572	64552	52	8.54%	0.0390	0.16	20
PI606A	0.4572	64570	70	17.59%	0.0804	0.36	0
PI606A	0.4572	64580	80	6.53%	0.0299	0.08	0
PI606A	0.4572	64598	98	67.34%	0.3079	0.37	0
PI609	1.9354	645112	112	1.64%	0.0317	0.39	0
PI609	1.9354	645115	115	6.20%	0.1200	0.39	0
PI609	1.9354	64552	52	1.29%	0.0250	0.16	20
PI609	1.9354	64555	55	1.17%	0.0226	0.27	0
PI609	1.9354	64558	58	6.90%	0.1335	0.34	0
PI609	1.9354	64570	70	28.65%	0.5545	0.36	0
PI609	1.9354	64578	78	1.75%	0.0339	0.05	0
PI609	1.9354	64580	80	6.78%	0.1312	0.08	0
PI609	1.9354	64598	98	12.87%	0.2491	0.37	0
PI609	1.9354	651203222	AGB	1.05%	0.0203	0.40	0
PI609	1.9354	651203424	AHC	8.07%	0.1562	0.38	0
PI609	1.9354	6513244	GM	21.87%	0.4233	0.29	0
PI609	1.9354	651445822	MTB	1.64%	0.0317	0.15	0
PI609	1.9354	6514462	MV	0.12%	0.0023	0.15	0
PI612	0.7378	645115	115	1.53%	0.0113	0.39	0
PI612	0.7378	64555	55	31.80%	0.2346	0.27	0
PI612	0.7378	64558	58	7.03%	0.0519	0.34	0
PI612	0.7378	64570	70	20.49%	0.1512	0.36	0
PI612	0.7378	64598	98	33.03%	0.2437	0.37	0
PI612	0.7378	651203424	AHC	0.92%	0.0068	0.38	0
PI612	0.7378	6513244	GM	5.20%	0.0384	0.29	0
PI615	0.8419	64555	55	29.81%	0.2510	0.27	0
PI615	0.8419	64570	70	5.69%	0.0479	0.36	0
PI615	0.8419	64598	98	64.50%	0.5431	0.37	0
PI618	0.2886	6453	3	1.60%	0.0046	0.58	0
PI618	0.2886	64555	55	96.00%	0.2771	0.27	0
PI618	0.2886	64598	98	2.40%	0.0069	0.37	0
PI621	0.9051	6512857	Es	12.84%	0.1162	0.25	0
PI621	0.9051	6513244	GM	82.47%	0.7464	0.29	0
PI621	0.9051	651445822	MTB	1.73%	0.0157	0.15	0
PI621	0.9051	6514462	MV	2.96%	0.0268	0.15	0
PI624	1.2251	651202720	AdA	0.56%	0.0069	0.40	0
PI624	1.2251	651202722	AdB	0.75%	0.0092	0.40	0
PI624	1.2251	6512857	Es	0.19%	0.0023	0.25	0

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Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PI624	1.2251	6513244	GM	70.06%	0.8583	0.29	0
PI624	1.2251	651445822	MTB	19.96%	0.2445	0.15	0
PI624	1.2251	6514462	MV	8.47%	0.1038	0.15	0
PI624A	2.8067	64555	55	7.88%	0.2212	0.27	0
PI624A	2.8067	64558	58	46.50%	1.3051	0.34	0
PI624A	2.8067	645999	999	1.69%	0.0474	0.00	0
PI624A	2.8067	6513244	GM	41.83%	1.1740	0.29	0
PI624A	2.8067	651445822	MTB	2.09%	0.0587	0.15	0
PI628	0.5695	64529	29	2.85%	0.0162	0.34	0
PI628	0.5695	64555	55	71.95%	0.4098	0.27	0
PI628	0.5695	64558	58	25.20%	0.1435	0.34	0
PI633	0.3359	651202320	AbA	0.68%	0.0023	0.38	0
PI633	0.3359	651202720	AdA	2.70%	0.0091	0.40	0
PI633	0.3359	651202722	AdB	1.35%	0.0045	0.40	0
PI633	0.3359	6512857	Es	1.35%	0.0045	0.25	0
PI633	0.3359	651323320	GgA	2.03%	0.0068	0.25	0
PI633	0.3359	6513244	GM	39.19%	0.1316	0.29	0
PI633	0.3359	651445822	MTB	12.16%	0.0408	0.15	0
PI633	0.3359	6514462	MV	40.54%	0.1362	0.15	0
PI635	0.6106	651202720	AdA	1.48%	0.0090	0.40	0
PI635	0.6106	651202722	AdB	11.44%	0.0699	0.40	0
PI635	0.6106	6512457	Cs	3.32%	0.0203	0.19	0
PI635	0.6106	6512857	Es	13.65%	0.0834	0.25	0
PI635	0.6106	651323320	GgA	1.48%	0.0090	0.25	0
PI635	0.6106	6514223	Lb	0.74%	0.0045	0.40	0
PI635	0.6106	6514451	Mp	36.53%	0.2231	0.25	0
PI635	0.6106	6514455	Mr	15.87%	0.0969	0.05	0
PI635	0.6106	651502922	PeB	0.37%	0.0023	0.38	0
PI635	0.6106	651585520	TrA	7.75%	0.0473	0.11	0
PI635	0.6106	651585522	TrB	1.85%	0.0113	0.13	0
PI635	0.6106	6516221	Va	1.11%	0.0068	0.39	0
PI635	0.6106	6516229	Ve	4.43%	0.0271	0.25	0
PI636	0.4286	651202720	AdA	6.01%	0.0258	0.40	0
PI636	0.4286	651202722	AdB	4.37%	0.0187	0.40	0
PI636	0.4286	651203424	AHC	15.85%	0.0679	0.38	0
PI636	0.4286	6512857	Es	5.46%	0.0234	0.25	0
PI636	0.4286	6513244	GM	59.02%	0.2530	0.29	0
PI636	0.4286	6514455	Mr	7.10%	0.0304	0.05	0
PI636	0.4286	651445822	MTB	2.19%	0.0094	0.15	0
PI639	0.3431	651202722	AdB	0.68%	0.0023	0.40	0
PI639	0.3431	651203222	AGB	2.70%	0.0093	0.40	0
PI639	0.3431	6513244	GM	89.86%	0.3083	0.29	0
PI639	0.3431	651445822	MTB	6.76%	0.0232	0.15	0
PI642	0.2367	645112	112	50.50%	0.1195	0.39	0
PI642	0.2367	64570	70	4.95%	0.0117	0.36	0
PI642	0.2367	64598	98	44.55%	0.1054	0.37	0
PI645	1.5619	645112	112	19.34%	0.3021	0.39	0
PI645	1.5619	645113	113	33.24%	0.5192	0.39	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PI645	1.5619	645114	114	0.86%	0.0134	0.39	0
PI645	1.5619	6452	2	2.29%	0.0358	0.41	0
PI645	1.5619	6453	3	4.01%	0.0626	0.58	0
PI645	1.5619	64555	55	18.19%	0.2841	0.27	0
PI645	1.5619	64598	98	22.06%	0.3446	0.37	0
PI645A	1.6307	64510	10	0.70%	0.0114	0.94	0
PI645A	1.6307	645110	110	0.84%	0.0137	0.13	0
PI645A	1.6307	645113	113	10.08%	0.1644	0.39	0
PI645A	1.6307	64529	29	4.48%	0.0731	0.34	0
PI645A	1.6307	64544	44	27.31%	0.4453	0.03	0
PI645A	1.6307	64545	45	36.97%	0.6029	0.03	0
PI645A	1.6307	64555	55	19.61%	0.3198	0.27	0
PI648	1.7278	645108	108	0.52%	0.0090	0.31	30
PI648	1.7278	645112	112	4.03%	0.0696	0.39	0
PI648	1.7278	645113	113	4.03%	0.0696	0.39	0
PI648	1.7278	64544	44	27.31%	0.4719	0.03	0
PI648	1.7278	64545	45	25.10%	0.4337	0.03	0
PI648	1.7278	64548	48	29.39%	0.5078	0.06	0
PI648	1.7278	64549	49	5.59%	0.0966	0.06	0
PI648	1.7278	64598	98	4.03%	0.0696	0.37	0
PI651	0.4594	645113	113	34.22%	0.1572	0.39	0
PI651	0.4594	645114	114	15.51%	0.0713	0.39	0
PI651	0.4594	64544	44	43.85%	0.2015	0.03	0
PI651	0.4594	64545	45	1.07%	0.0049	0.03	0
PI651	0.4594	64549	49	5.35%	0.0246	0.06	0
PI654	4.0277	645108	108	0.06%	0.0024	0.31	30
PI654	4.0277	645112	112	0.06%	0.0024	0.39	0
PI654	4.0277	645113	113	1.51%	0.0608	0.39	0
PI654	4.0277	645114	114	0.84%	0.0338	0.39	0
PI654	4.0277	64544	44	23.59%	0.9501	0.03	0
PI654	4.0277	64545	45	46.28%	1.8640	0.03	0
PI654	4.0277	64549	49	0.17%	0.0068	0.06	0
PI654	4.0277	64574	74	27.50%	1.1076	0.08	0
PI657	0.8697	64544	44	32.81%	0.2854	0.03	0
PI657	0.8697	64545	45	51.71%	0.4497	0.03	0
PI657	0.8697	64548	48	3.94%	0.0343	0.06	0
PI657	0.8697	64549	49	1.31%	0.0114	0.06	0
PI657	0.8697	64574	74	10.24%	0.0891	0.08	0
PI660	0.8393	645114	114	0.27%	0.0023	0.39	0
PI660	0.8393	64544	44	37.00%	0.3105	0.03	0
PI660	0.8393	64545	45	28.69%	0.2408	0.03	0
PI660	0.8393	64574	74	16.89%	0.1418	0.08	0
PI660	0.8393	64580	80	17.16%	0.1440	0.08	0
PI663	0.6041	64533	33	3.04%	0.0184	0.23	0
PI663	0.6041	64544	44	61.98%	0.3744	0.03	0
PI663	0.6041	64545	45	6.46%	0.0390	0.03	0
PI663	0.6041	64563	63	6.08%	0.0367	0.14	25
PI663	0.6041	64580	80	22.43%	0.1355	0.08	0

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Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PI669	0.2856	64555	55	100.00%	0.2856	0.27	0
PI672	1.5104	64529	29	46.58%	0.7035	0.34	0
PI672	1.5104	64544	44	0.30%	0.0045	0.03	0
PI672	1.5104	64555	55	23.81%	0.3596	0.27	0
PI672	1.5104	64558	58	29.32%	0.4428	0.34	0
PI675	0.0628	64555	55	80.00%	0.0502	0.27	0
PI675	0.0628	64558	58	20.00%	0.0126	0.34	0
PI678	0.8324	64510	10	1.68%	0.0140	0.94	0
PI678	0.8324	645110	110	0.28%	0.0023	0.13	0
PI678	0.8324	64529	29	68.91%	0.5736	0.34	0
PI678	0.8324	64555	55	17.09%	0.1423	0.27	0
PI678	0.8324	64558	58	12.04%	0.1002	0.34	0
PI681	0.9914	64510	10	18.01%	0.1786	0.94	0
PI681	0.9914	645110	110	4.85%	0.0481	0.13	0
PI681	0.9914	64544	44	32.10%	0.3182	0.03	0
PI681	0.9914	64545	45	45.03%	0.4464	0.03	0
PI684	0.7361	64510	10	16.46%	0.1212	0.94	0
PI684	0.7361	645108	108	4.35%	0.0320	0.31	30
PI684	0.7361	64544	44	42.55%	0.3132	0.03	0
PI684	0.7361	64545	45	10.25%	0.0755	0.03	0
PI684	0.7361	64549	49	10.87%	0.0800	0.06	0
PI684	0.7361	64574	74	15.53%	0.1143	0.08	0
PI687	7.0093	64510	10	0.19%	0.0133	0.94	0
PI687	7.0093	64531	31	34.70%	2.4322	0.33	35
PI687	7.0093	64533	33	1.32%	0.0925	0.23	0
PI687	7.0093	64534	34	3.72%	0.2607	0.23	0
PI687	7.0093	64544	44	0.45%	0.0315	0.03	0
PI687	7.0093	64545	45	0.10%	0.0070	0.03	0
PI687	7.0093	64563	63	41.70%	2.9229	0.14	25
PI687	7.0093	64572	72	13.19%	0.9245	0.09	30
PI687	7.0093	64574	74	1.57%	0.1100	0.08	0
PI687	7.0093	6458	8	3.05%	0.2138	0.96	0
PI688	3.1968	637244526	CmD	24.31%	0.7771	0.00	0
PI688	3.1968	6374229	Le	11.60%	0.3708	0.00	0
PI688	3.1968	6374235	Lh	10.89%	0.3481	0.00	0
PI688	3.1968	64516	16	2.25%	0.0719	0.44	15
PI688	3.1968	64531	31	25.09%	0.8021	0.33	35
PI688	3.1968	64563	63	9.42%	0.3011	0.14	25
PI688	3.1968	64572	72	14.62%	0.4674	0.09	30
PI688	3.1968	6458	8	1.83%	0.0585	0.96	0
PI689	6.7846	637244526	CmD	34.12%	2.3149	0.00	0
PI689	6.7846	6374229	Le	14.76%	1.0014	0.00	0
PI689	6.7846	6374235	Lh	13.77%	0.9342	0.00	0
PI689	6.7846	6375455	Rr	5.63%	0.3820	0.00	0
PI689	6.7846	645104	104	0.33%	0.0224	0.14	60
PI689	6.7846	64516	16	3.34%	0.2266	0.44	15
PI689	6.7846	64563	63	4.67%	0.3168	0.14	25
PI689	6.7846	64572	72	22.27%	1.5109	0.09	30

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JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
PI689	6.7846	6458	8	1.13%	0.0767	0.96	0
PI690	0.6289	64529	29	61.17%	0.3847	0.34	0
PI690	0.6289	64555	55	10.99%	0.0691	0.27	0
PI690	0.6289	64558	58	27.11%	0.1705	0.34	0
PI690	0.6289	64575	75	0.73%	0.0046	0.23	0
PI693	0.8361	64529	29	2.17%	0.0181	0.34	0
PI693	0.8361	64555	55	8.70%	0.0727	0.27	0
PI693	0.8361	64558	58	53.53%	0.4476	0.34	0
PI693	0.8361	64575	75	35.60%	0.2977	0.23	0
SV200	2.2918	6451	1	1.08%	0.0248	0.41	0
SV200	2.2918	645112	112	31.08%	0.7123	0.39	0
SV200	2.2918	64529	29	0.20%	0.0046	0.34	0
SV200	2.2918	6453	3	1.57%	0.0360	0.58	0
SV200	2.2918	64553	53	2.84%	0.0651	0.02	0
SV200	2.2918	64555	55	13.14%	0.3011	0.27	0
SV200	2.2918	64575	75	15.10%	0.3461	0.23	0
SV200	2.2918	64576	76	1.47%	0.0337	0.23	0
SV200	2.2918	651203222	AGB	1.18%	0.0270	0.40	0
SV200	2.2918	6512042	AL	5.69%	0.1304	0.40	0
SV200	2.2918	6513244	GM	14.80%	0.3392	0.29	0
SV200	2.2918	651445822	MTB	9.22%	0.2113	0.15	0
SV200	2.2918	651585624	TSC	2.65%	0.0607	0.14	0
SV202	1.4365	645112	112	25.97%	0.3731	0.39	0
SV202	1.4365	64522	22	19.60%	0.2816	0.04	0
SV202	1.4365	64553	53	22.55%	0.3239	0.02	0
SV202	1.4365	64555	55	2.02%	0.0290	0.27	0
SV202	1.4365	64564	64	0.78%	0.0112	0.14	25
SV202	1.4365	64576	76	25.97%	0.3731	0.23	0
SV202	1.4365	64578	78	3.11%	0.0447	0.05	0
SV203	0.0760	645112	112	92.86%	0.0705	0.39	0
SV203	0.0760	64575	75	7.14%	0.0054	0.23	0
SV205	0.5022	645100	100	33.94%	0.1704	0.40	20
SV205	0.5022	645112	112	9.17%	0.0460	0.39	0
SV205	0.5022	64548	48	56.88%	0.2856	0.06	0
SV208	1.0674	645100	100	75.80%	0.8091	0.40	20
SV208	1.0674	645112	112	6.42%	0.0685	0.39	0
SV208	1.0674	6453	3	1.93%	0.0206	0.58	0
SV208	1.0674	64548	48	15.85%	0.1692	0.06	0
SV210	0.7184	645100	100	20.19%	0.1451	0.40	20
SV210	0.7184	645112	112	14.42%	0.1036	0.39	0
SV210	0.7184	6453	3	12.50%	0.0898	0.58	0
SV210	0.7184	64548	48	52.56%	0.3776	0.06	0
SV210	0.7184	64570	70	0.32%	0.0023	0.36	0
SV212	4.1391	645112	112	11.79%	0.4880	0.39	0
SV212	4.1391	645113	113	7.91%	0.3274	0.39	0
SV212	4.1391	645124	124	12.06%	0.4992	0.39	0
SV212	4.1391	64522	22	5.40%	0.2235	0.04	0
SV212	4.1391	64529	29	15.94%	0.6598	0.34	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
SV212	4.1391	64553	53	2.24%	0.0927	0.02	0
SV212	4.1391	64555	55	33.46%	1.3849	0.27	0
SV212	4.1391	64570	70	0.98%	0.0406	0.36	0
SV212	4.1391	64576	76	5.08%	0.2103	0.23	0
SV212	4.1391	64577	77	5.13%	0.2123	0.05	0
SV214	1.8700	645112	112	4.62%	0.0864	0.39	0
SV214	1.8700	645113	113	12.03%	0.2250	0.39	0
SV214	1.8700	645124	124	5.83%	0.1090	0.39	0
SV214	1.8700	64522	22	0.73%	0.0137	0.04	0
SV214	1.8700	64529	29	7.17%	0.1341	0.34	0
SV214	1.8700	64550	50	2.07%	0.0387	0.26	0
SV214	1.8700	64553	53	0.85%	0.0159	0.02	0
SV214	1.8700	64555	55	4.25%	0.0795	0.27	0
SV214	1.8700	64570	70	5.59%	0.1045	0.36	0
SV214	1.8700	64575	75	36.57%	0.6838	0.23	0
SV214	1.8700	64576	76	0.73%	0.0137	0.23	0
SV214	1.8700	64577	77	19.56%	0.3658	0.05	0
SV216	1.6268	645112	112	0.29%	0.0047	0.39	0
SV216	1.6268	645113	113	17.12%	0.2785	0.39	0
SV216	1.6268	64529	29	4.85%	0.0789	0.34	0
SV216	1.6268	6453	3	3.00%	0.0488	0.58	0
SV216	1.6268	64548	48	6.56%	0.1067	0.06	0
SV216	1.6268	64550	50	11.98%	0.1949	0.26	0
SV216	1.6268	64553	53	5.56%	0.0905	0.02	0
SV216	1.6268	64564	64	0.14%	0.0023	0.14	25
SV216	1.6268	64575	75	30.24%	0.4920	0.23	0
SV216	1.6268	64576	76	9.70%	0.1578	0.23	0
SV216	1.6268	64577	77	10.56%	0.1718	0.05	0
SV218	1.2862	645113	113	15.23%	0.1959	0.39	0
SV218	1.2862	645124	124	2.57%	0.0331	0.39	0
SV218	1.2862	6452	2	2.02%	0.0260	0.41	0
SV218	1.2862	64522	22	3.67%	0.0472	0.04	0
SV218	1.2862	64550	50	35.05%	0.4508	0.26	0
SV218	1.2862	64553	53	6.61%	0.0850	0.02	0
SV218	1.2862	64575	75	8.44%	0.1086	0.23	0
SV218	1.2862	64576	76	15.41%	0.1982	0.23	0
SV218	1.2862	64577	77	11.01%	0.1416	0.05	0
SV219	0.8972	645113	113	0.25%	0.0022	0.39	0
SV219	0.8972	645124	124	30.73%	0.2757	0.39	0
SV219	0.8972	64522	22	26.20%	0.2351	0.04	0
SV219	0.8972	6453	3	2.27%	0.0204	0.58	0
SV219	0.8972	64553	53	6.55%	0.0588	0.02	0
SV219	0.8972	64575	75	15.37%	0.1379	0.23	0
SV219	0.8972	64576	76	6.30%	0.0565	0.23	0
SV219	0.8972	64577	77	12.34%	0.1107	0.05	0
SV220	0.6004	64522	22	9.09%	0.0546	0.04	0
SV220	0.6004	64553	53	20.08%	0.1206	0.02	0
SV220	0.6004	64555	55	1.89%	0.0113	0.27	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
SV220	0.6004	64570	70	20.08%	0.1206	0.36	0
SV220	0.6004	64576	76	48.86%	0.2933	0.23	0
SV230	0.8513	645100	100	32.28%	0.2748	0.40	20
SV230	0.8513	645112	112	1.84%	0.0157	0.39	0
SV230	0.8513	64548	48	48.56%	0.4134	0.06	0
SV230	0.8513	64549	49	5.51%	0.0469	0.06	0
SV230	0.8513	64570	70	11.81%	0.1005	0.36	0
SV232	3.0569	645100	100	34.98%	1.0693	0.40	20
SV232	3.0569	645112	112	6.37%	0.1947	0.39	0
SV232	3.0569	645124	124	0.37%	0.0113	0.39	0
SV232	3.0569	64529	29	7.19%	0.2198	0.34	0
SV232	3.0569	64548	48	46.74%	1.4288	0.06	0
SV232	3.0569	64549	49	3.37%	0.1030	0.06	0
SV232	3.0569	64570	70	0.97%	0.0297	0.36	0
SV236	0.5856	645112	112	3.11%	0.0182	0.39	0
SV236	0.5856	645113	113	32.68%	0.1914	0.39	0
SV236	0.5856	645124	124	15.56%	0.0911	0.39	0
SV236	0.5856	64529	29	48.64%	0.2848	0.34	0
SV240	3.6651	645100	100	46.15%	1.6914	0.40	20
SV240	3.6651	645124	124	0.18%	0.0066	0.39	0
SV240	3.6651	64529	29	21.57%	0.7906	0.34	0
SV240	3.6651	64548	48	32.10%	1.1765	0.06	0
SV242	0.0939	64529	29	100.00%	0.0939	0.34	0
SV244	0.9461	645100	100	8.53%	0.0807	0.40	20
SV244	0.9461	645115	115	5.69%	0.0538	0.39	0
SV244	0.9461	64529	29	21.33%	0.2018	0.34	0
SV244	0.9461	64548	48	59.72%	0.5650	0.06	0
SV244	0.9461	64549	49	4.74%	0.0448	0.06	0
SV246	0.1567	645113	113	15.00%	0.0235	0.39	0
SV246	0.1567	6453	3	1.67%	0.0026	0.58	0
SV246	0.1567	64548	48	83.33%	0.1306	0.06	0
SV248	1.2718	645100	100	50.89%	0.6472	0.40	20
SV248	1.2718	645113	113	1.43%	0.0182	0.39	0
SV248	1.2718	645115	115	4.11%	0.0523	0.39	0
SV248	1.2718	6453	3	6.43%	0.0818	0.58	0
SV248	1.2718	64548	48	17.50%	0.2226	0.06	0
SV248	1.2718	64549	49	19.64%	0.2498	0.06	0
SV250	0.1213	645113	113	81.13%	0.0984	0.39	0
SV250	0.1213	6453	3	1.89%	0.0023	0.58	0
SV250	0.1213	64548	48	16.98%	0.0206	0.06	0
SV251	0.2675	645113	113	87.27%	0.2334	0.39	0
SV251	0.2675	6453	3	12.73%	0.0341	0.58	0
SV252	0.1473	645113	113	62.50%	0.0921	0.39	0
SV252	0.1473	645124	124	15.62%	0.0230	0.39	0
SV252	0.1473	6453	3	21.88%	0.0322	0.58	0
SV254	0.0971	645113	113	45.95%	0.0446	0.39	0
SV254	0.0971	645124	124	40.54%	0.0394	0.39	0
SV254	0.0971	6453	3	13.51%	0.0131	0.58	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
SV256	0.0604	645113	113	4.76%	0.0029	0.39	0
SV256	0.0604	6453	3	95.24%	0.0576	0.58	0
SV258	0.7359	645100	100	31.82%	0.2342	0.40	20
SV258	0.7359	6453	3	8.79%	0.0647	0.58	0
SV258	0.7359	64548	48	48.18%	0.3546	0.06	0
SV258	0.7359	64549	49	11.21%	0.0825	0.06	0
SV260	1.2629	645112	112	14.57%	0.1840	0.39	0
SV260	1.2629	64522	22	10.07%	0.1272	0.04	0
SV260	1.2629	64553	53	19.24%	0.2430	0.02	0
SV260	1.2629	64570	70	19.60%	0.2475	0.36	0
SV260	1.2629	64576	76	36.51%	0.4611	0.23	0
SV264	1.9190	645112	112	18.60%	0.3569	0.39	0
SV264	1.9190	64522	22	20.14%	0.3865	0.04	0
SV264	1.9190	64553	53	31.64%	0.6072	0.02	0
SV264	1.9190	64576	76	29.62%	0.5684	0.23	0
SV264A	2.8970	645112	112	33.67%	0.9754	0.39	0
SV264A	2.8970	64522	22	11.17%	0.3236	0.04	0
SV264A	2.8970	64553	53	37.73%	1.0930	0.02	0
SV264A	2.8970	64576	76	17.42%	0.5047	0.23	0
SV268	1.3755	64522	22	45.17%	0.6213	0.04	0
SV268	1.3755	64553	53	30.44%	0.4187	0.02	0
SV268	1.3755	64576	76	24.39%	0.3355	0.23	0
SV272	1.2010	645112	112	44.94%	0.5397	0.39	0
SV272	1.2010	64522	22	21.91%	0.2631	0.04	0
SV272	1.2010	64553	53	21.35%	0.2564	0.02	0
SV272	1.2010	64570	70	9.18%	0.1102	0.36	0
SV272	1.2010	64576	76	2.62%	0.0315	0.23	0
SV276	0.9233	645112	112	19.46%	0.1797	0.39	0
SV276	0.9233	645113	113	2.43%	0.0224	0.39	0
SV276	0.9233	64522	22	39.90%	0.3684	0.04	0
SV276	0.9233	64553	53	18.73%	0.1729	0.02	0
SV276	0.9233	64570	70	19.46%	0.1797	0.36	0
SV280	1.0563	645112	112	0.42%	0.0044	0.39	0
SV280	1.0563	645113	113	10.40%	0.1099	0.39	0
SV280	1.0563	64522	22	47.77%	0.5046	0.04	0
SV280	1.0563	64553	53	25.05%	0.2646	0.02	0
SV280	1.0563	64570	70	10.83%	0.1144	0.36	0
SV280	1.0563	64576	76	5.52%	0.0583	0.23	0
SV284	0.2834	645112	112	38.02%	0.1077	0.39	0
SV284	0.2834	64522	22	29.75%	0.0843	0.04	0
SV284	0.2834	64553	53	32.23%	0.0913	0.02	0
SV286	1.5380	645112	112	40.71%	0.6261	0.39	0
SV286	1.5380	64522	22	0.88%	0.0135	0.04	0
SV286	1.5380	64553	53	40.56%	0.6238	0.02	0
SV286	1.5380	64576	76	16.08%	0.2473	0.23	0
SV286	1.5380	64580	80	1.77%	0.0272	0.08	0
SV290	0.8137	645112	112	63.81%	0.5192	0.39	0
SV290	0.8137	64522	22	6.91%	0.0562	0.04	0

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Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
SV290	0.8137	64553	53	29.28%	0.2383	0.02	0
SV294	2.6465	645110	110	6.04%	0.1598	0.13	0
SV294	2.6465	645112	112	16.75%	0.4433	0.39	0
SV294	2.6465	64522	22	26.36%	0.6976	0.04	0
SV294	2.6465	64546	46	6.29%	0.1665	0.03	0
SV294	2.6465	64553	53	33.50%	0.8866	0.02	0
SV294	2.6465	64570	70	0.09%	0.0024	0.36	0
SV294	2.6465	64576	76	6.72%	0.1778	0.23	0
SV294	2.6465	64578	78	4.25%	0.1125	0.05	0
SV298	1.0753	645112	112	24.46%	0.2630	0.39	0
SV298	1.0753	645113	113	0.86%	0.0092	0.39	0
SV298	1.0753	64522	22	40.56%	0.4361	0.04	0
SV298	1.0753	64553	53	28.76%	0.3093	0.02	0
SV298	1.0753	64576	76	5.36%	0.0576	0.23	0
TW400	4.2709	651323320	GgA	3.27%	0.1397	0.25	0
TW400	4.2709	6513244	GM	39.98%	1.7075	0.29	0
TW400	4.2709	651445822	MTB	54.48%	2.3268	0.15	0
TW400	4.2709	651585522	TrB	1.27%	0.0542	0.13	0
TW400	4.2709	651585624	TSC	1.00%	0.0427	0.14	0
TW402	4.9144	651203222	AGB	9.03%	0.4438	0.40	0
TW402	4.9144	6512042	AL	12.01%	0.5902	0.40	0
TW402	4.9144	651285026	EPD	1.88%	0.0924	0.12	0
TW402	4.9144	651323320	GgA	2.71%	0.1332	0.25	0
TW402	4.9144	6513244	GM	17.15%	0.8428	0.29	0
TW402	4.9144	651326722	GxB	0.05%	0.0025	0.24	0
TW402	4.9144	651422520	LcA	0.18%	0.0088	0.25	0
TW402	4.9144	6514455	Mr	0.46%	0.0226	0.05	0
TW402	4.9144	651445822	MTB	34.07%	1.6743	0.15	0
TW402	4.9144	651505422	PRB	4.59%	0.2256	0.28	0
TW402	4.9144	651585522	TrB	5.23%	0.2570	0.13	0
TW402	4.9144	651585624	TSC	11.00%	0.5406	0.14	0
TW402	4.9144	6516229	Ve	0.50%	0.0246	0.25	0
TW402	4.9144	6516255	Vr	1.15%	0.0565	0.63	0
TW404	2.0927	651202720	AdA	0.98%	0.0205	0.40	0
TW404	2.0927	6512029	Ae	1.53%	0.0320	0.39	0
TW404	2.0927	651203222	AGB	12.01%	0.2513	0.40	0
TW404	2.0927	6512042	AL	40.72%	0.8522	0.40	0
TW404	2.0927	6512257	Bs	0.22%	0.0046	0.39	0
TW404	2.0927	6512448	CO	0.98%	0.0205	0.29	20
TW404	2.0927	6512451	Cp	0.98%	0.0205	0.40	0
TW404	2.0927	6512457	Cs	1.09%	0.0228	0.19	0
TW404	2.0927	651285026	EPD	2.51%	0.0525	0.12	0
TW404	2.0927	651323320	GgA	8.62%	0.1804	0.25	0
TW404	2.0927	6514451	Mp	2.95%	0.0617	0.25	0
TW404	2.0927	6514455	Mr	3.82%	0.0799	0.05	0
TW404	2.0927	651445822	MTB	6.99%	0.1463	0.15	0
TW404	2.0927	6515833	Tg	1.86%	0.0389	0.04	0
TW404	2.0927	651585520	TrA	0.76%	0.0159	0.11	0

APPENDIX D.2.1: Soil Type Summary

Entellus

SHEET		OF	
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CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
TW404	2.0927	651585522	TrB	0.66%	0.0138	0.13	0
TW404	2.0927	6516229	Ve	8.52%	0.1783	0.25	0
TW404	2.0927	6516231	Vf	4.80%	0.1005	0.01	0
TW406	0.1633	651203222	AGB	2.90%	0.0047	0.40	0
TW406	0.1633	6512448	CO	36.23%	0.0591	0.29	20
TW406	0.1633	651285026	EPD	60.87%	0.0994	0.12	0
TW408	0.9101	645100	100	73.72%	0.6709	0.40	20
TW408	0.9101	6512448	CO	9.69%	0.0882	0.29	20
TW408	0.9101	651285026	EPD	11.73%	0.1068	0.12	0
TW408	0.9101	6515456	RS	4.85%	0.0441	0.40	65
TW410	0.3080	651203222	AGB	9.85%	0.0303	0.40	0
TW410	0.3080	6512042	AL	28.79%	0.0887	0.40	0
TW410	0.3080	6513244	GM	61.36%	0.1890	0.29	0
TW412	2.0637	645112	112	8.35%	0.1723	0.39	0
TW412	2.0637	64522	22	0.22%	0.0045	0.04	0
TW412	2.0637	64553	53	3.47%	0.0716	0.02	0
TW412	2.0637	6513244	GM	14.53%	0.2999	0.29	0
TW412	2.0637	651445822	MTB	30.04%	0.6199	0.15	0
TW412	2.0637	651585624	TSC	43.38%	0.8952	0.14	0
TW414	1.1684	6451	1	1.55%	0.0181	0.41	0
TW414	1.1684	645100	100	24.85%	0.2904	0.40	20
TW414	1.1684	645112	112	4.27%	0.0499	0.39	0
TW414	1.1684	645115	115	8.74%	0.1021	0.39	0
TW414	1.1684	6453	3	3.88%	0.0453	0.58	0
TW414	1.1684	64548	48	35.34%	0.4129	0.06	0
TW414	1.1684	651203222	AGB	13.20%	0.1542	0.40	0
TW414	1.1684	6512042	AL	1.17%	0.0137	0.40	0
TW414	1.1684	651285026	EPD	5.83%	0.0681	0.12	0
TW414	1.1684	6515456	RS	1.17%	0.0137	0.40	65
TW416	0.5883	645112	112	53.52%	0.3149	0.39	0
TW416	0.5883	645113	113	2.34%	0.0138	0.39	0
TW416	0.5883	64522	22	1.17%	0.0069	0.04	0
TW416	0.5883	64553	53	22.27%	0.1310	0.02	0
TW416	0.5883	64598	98	1.56%	0.0092	0.37	0
TW416	0.5883	6513244	GM	0.78%	0.0046	0.29	0
TW416	0.5883	651445822	MTB	18.36%	0.1080	0.15	0
TW418	1.3681	645112	112	19.21%	0.2628	0.39	0
TW418	1.3681	645113	113	4.43%	0.0606	0.39	0
TW418	1.3681	6452	2	0.16%	0.0022	0.41	0
TW418	1.3681	64522	22	8.70%	0.1190	0.04	0
TW418	1.3681	64553	53	8.21%	0.1123	0.02	0
TW418	1.3681	64557	57	7.06%	0.0966	0.06	0
TW418	1.3681	64580	80	36.45%	0.4987	0.08	0
TW418	1.3681	6513244	GM	12.81%	0.1753	0.29	0
TW418	1.3681	651445822	MTB	2.96%	0.0405	0.15	0
TW420	0.8077	645112	112	53.80%	0.4346	0.39	0
TW420	0.8077	64522	22	3.94%	0.0318	0.04	0
TW420	0.8077	64553	53	18.03%	0.1456	0.02	0

APPENDIX D.2.1: Soil Type Summary

Entellus

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JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
TW420	0.8077	6513244	GM	7.61%	0.0615	0.29	0
TW420	0.8077	651445822	MTB	14.65%	0.1183	0.15	0
TW420	0.8077	651585624	TSC	1.97%	0.0159	0.14	0
TW422	0.7032	64580	80	0.33%	0.0023	0.08	0
TW422	0.7032	6513244	GM	30.62%	0.2153	0.29	0
TW422	0.7032	651445822	MTB	69.06%	0.4856	0.15	0
TW424	1.4967	64555	55	9.50%	0.1422	0.27	0
TW424	1.4967	64558	58	2.02%	0.0302	0.34	0
TW424	1.4967	64564	64	0.31%	0.0046	0.14	25
TW424	1.4967	64575	75	2.34%	0.0350	0.23	0
TW424	1.4967	64577	77	23.52%	0.3520	0.05	0
TW424	1.4967	64580	80	29.75%	0.4453	0.08	0
TW424	1.4967	6513244	GM	4.52%	0.0676	0.29	0
TW424	1.4967	651445822	MTB	28.04%	0.4197	0.15	0
TW429	0.5553	645112	112	9.05%	0.0503	0.39	0
TW429	0.5553	645113	113	7.00%	0.0389	0.39	0
TW429	0.5553	64522	22	41.98%	0.2331	0.04	0
TW429	0.5553	64553	53	10.70%	0.0594	0.02	0
TW429	0.5553	64578	78	9.47%	0.0526	0.05	0
TW429	0.5553	64580	80	21.81%	0.1211	0.08	0
TW430	2.4917	645112	112	26.76%	0.6668	0.39	0
TW430	2.4917	645113	113	1.99%	0.0496	0.39	0
TW430	2.4917	6452	2	2.98%	0.0743	0.41	0
TW430	2.4917	64553	53	2.89%	0.0720	0.02	0
TW430	2.4917	64555	55	8.23%	0.2051	0.27	0
TW430	2.4917	64557	57	2.53%	0.0630	0.06	0
TW430	2.4917	64577	77	23.15%	0.5768	0.05	0
TW430	2.4917	64578	78	2.08%	0.0518	0.05	0
TW430	2.4917	64580	80	29.39%	0.7323	0.08	0
TW431	0.8733	645112	112	11.17%	0.0975	0.39	0
TW431	0.8733	645113	113	2.34%	0.0204	0.39	0
TW431	0.8733	64553	53	0.52%	0.0045	0.02	0
TW431	0.8733	64577	77	38.18%	0.3334	0.05	0
TW431	0.8733	64580	80	47.79%	0.4173	0.08	0
TW432	0.8620	645113	113	16.71%	0.1440	0.39	0
TW432	0.8620	64544	44	12.01%	0.1035	0.03	0
TW432	0.8620	64577	77	4.44%	0.0383	0.05	0
TW432	0.8620	64580	80	8.09%	0.0697	0.08	0
TW432	0.8620	64598	98	58.75%	0.5064	0.37	0
TW434	0.5691	645112	112	22.97%	0.1307	0.39	0
TW434	0.5691	645113	113	35.59%	0.2025	0.39	0
TW434	0.5691	64522	22	23.42%	0.1333	0.04	0
TW434	0.5691	64555	55	2.70%	0.0154	0.27	0
TW434	0.5691	64577	77	15.32%	0.0872	0.05	0
TW436	0.6744	645112	112	19.59%	0.1321	0.39	0
TW436	0.6744	645113	113	10.31%	0.0695	0.39	0
TW436	0.6744	64555	55	3.78%	0.0255	0.27	0
TW436	0.6744	64577	77	65.98%	0.4450	0.05	0

APPENDIX D.2.1: Soil Type Summary

Entellus

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JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
TW436	0.6744	64580	80	0.34%	0.0023	0.08	0
TW440	0.1083	645113	113	60.00%	0.0650	0.39	0
TW440	0.1083	64522	22	37.78%	0.0409	0.04	0
TW440	0.1083	64544	44	2.22%	0.0024	0.03	0
TW442	0.3766	645113	113	1.94%	0.0073	0.39	0
TW442	0.3766	64522	22	46.45%	0.1749	0.04	0
TW442	0.3766	64544	44	9.68%	0.0365	0.03	0
TW442	0.3766	64577	77	1.29%	0.0049	0.05	0
TW442	0.3766	64598	98	40.65%	0.1531	0.37	0
TW444	0.3468	645113	113	8.03%	0.0278	0.39	0
TW444	0.3468	64544	44	41.61%	0.1443	0.03	0
TW444	0.3468	64598	98	50.36%	0.1746	0.37	0
TW446	0.3542	645113	113	1.39%	0.0049	0.39	0
TW446	0.3542	64544	44	95.83%	0.3394	0.03	0
TW446	0.3542	64598	98	2.78%	0.0098	0.37	0
TW446A	0.3372	64544	44	61.74%	0.2082	0.03	0
TW446A	0.3372	64573	73	38.26%	0.1290	0.09	30
TW448	0.3469	64544	44	95.27%	0.3305	0.03	0
TW448	0.3469	64573	73	4.73%	0.0164	0.09	30
TW450	1.2535	6453	3	2.74%	0.0343	0.58	0
TW450	1.2535	64544	44	62.71%	0.7861	0.03	0
TW450	1.2535	64545	45	21.57%	0.2704	0.03	0
TW450	1.2535	64573	73	6.40%	0.0802	0.09	30
TW450	1.2535	64598	98	6.58%	0.0825	0.37	0
TW450A	0.8811	645110	110	1.81%	0.0159	0.13	0
TW450A	0.8811	64538	38	17.05%	0.1502	0.13	0
TW450A	0.8811	64539	39	19.38%	0.1708	0.29	0
TW450A	0.8811	64545	45	53.49%	0.4713	0.03	0
TW450A	0.8811	64548	48	6.46%	0.0569	0.06	0
TW450A	0.8811	64568	68	1.81%	0.0159	0.63	0
TW450B	0.4043	645110	110	0.56%	0.0023	0.13	0
TW450B	0.4043	645113	113	9.50%	0.0384	0.39	0
TW450B	0.4043	6453	3	8.38%	0.0339	0.58	0
TW450B	0.4043	64544	44	23.46%	0.0948	0.03	0
TW450B	0.4043	64545	45	54.19%	0.2191	0.03	0
TW450B	0.4043	64548	48	3.91%	0.0158	0.06	0
TW452	0.4617	645113	113	6.40%	0.0295	0.39	0
TW452	0.4617	64544	44	92.61%	0.4276	0.03	0
TW452	0.4617	64598	98	0.99%	0.0046	0.37	0
TW452A	1.0764	645110	110	2.97%	0.0320	0.13	0
TW452A	1.0764	64538	38	43.22%	0.4652	0.13	0
TW452A	1.0764	64543	43	2.12%	0.0228	0.17	0
TW452A	1.0764	64545	45	45.97%	0.4948	0.03	0
TW452A	1.0764	64568	68	5.72%	0.0616	0.63	0
TW452B	1.0314	645110	110	6.74%	0.0695	0.13	0
TW452B	1.0314	64544	44	13.91%	0.1435	0.03	0
TW452B	1.0314	64545	45	46.09%	0.4754	0.03	0
TW452B	1.0314	64598	98	33.26%	0.3430	0.37	0

APPENDIX D.2.1: Soil Type Summary

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Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
TW454	0.3557	645110	110	15.17%	0.0540	0.13	0
TW454	0.3557	64544	44	4.14%	0.0147	0.03	0
TW454	0.3557	64545	45	13.10%	0.0466	0.03	0
TW454	0.3557	64598	98	67.59%	0.2404	0.37	0
TW456	0.1764	64574	74	59.15%	0.1043	0.08	0
TW456	0.1764	64598	98	40.85%	0.0720	0.37	0
TW458	0.6697	645110	110	0.34%	0.0023	0.13	0
TW458	0.6697	64545	45	73.06%	0.4893	0.03	0
TW458	0.6697	64574	74	13.13%	0.0879	0.08	0
TW458	0.6697	64598	98	13.47%	0.0902	0.37	0
TW459	1.0450	64538	38	14.29%	0.1493	0.13	0
TW459	1.0450	64539	39	35.06%	0.3664	0.29	0
TW459	1.0450	64543	43	24.68%	0.2579	0.17	0
TW459	1.0450	64544	44	9.31%	0.0973	0.03	0
TW459	1.0450	64545	45	10.82%	0.1131	0.03	0
TW459	1.0450	64548	48	0.22%	0.0023	0.06	0
TW459	1.0450	64568	68	5.63%	0.0588	0.63	0
TW460	2.3156	645121	121	3.87%	0.0896	0.12	0
TW460	2.3156	64538	38	16.92%	0.3918	0.13	0
TW460	2.3156	64542	42	15.47%	0.3582	0.17	0
TW460	2.3156	64543	43	18.67%	0.4323	0.17	0
TW460	2.3156	64545	45	1.64%	0.0380	0.03	0
TW460	2.3156	64562	62	18.86%	0.4367	0.15	0
TW460	2.3156	64563	63	15.47%	0.3582	0.14	25
TW460	2.3156	64568	68	0.19%	0.0044	0.63	0
TW460	2.3156	64574	74	1.55%	0.0359	0.08	0
TW460	2.3156	64594	94	5.03%	0.1165	0.33	0
TW460	2.3156	64598	98	2.32%	0.0537	0.37	0
TW462	0.0799	6453	3	8.00%	0.0064	0.58	0
TW462	0.0799	64544	44	92.00%	0.0735	0.03	0
TW478	0.2625	645112	112	15.04%	0.0395	0.39	0
TW478	0.2625	64575	75	38.94%	0.1022	0.23	0
TW478	0.2625	64577	77	44.25%	0.1162	0.05	0
TW478	0.2625	64580	80	1.77%	0.0046	0.08	0
TW480	0.7539	645112	112	9.79%	0.0738	0.39	0
TW480	0.7539	645113	113	0.92%	0.0069	0.39	0
TW480	0.7539	64575	75	24.46%	0.1844	0.23	0
TW480	0.7539	64577	77	63.91%	0.4818	0.05	0
TW480	0.7539	64580	80	0.92%	0.0069	0.08	0
TW482	0.7565	645113	113	7.58%	0.0573	0.39	0
TW482	0.7565	64575	75	84.24%	0.6373	0.23	0
TW482	0.7565	64577	77	8.18%	0.0619	0.05	0
TW484	0.3477	645113	113	60.69%	0.2110	0.39	0
TW484	0.3477	64544	44	29.66%	0.1031	0.03	0
TW484	0.3477	64577	77	9.66%	0.0336	0.05	0
TW485	2.3729	645113	113	56.19%	1.3333	0.39	0
TW485	2.3729	64544	44	22.00%	0.5220	0.03	0
TW485	2.3729	64574	74	16.81%	0.3989	0.08	0

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Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
TW485	2.3729	64575	75	1.98%	0.0470	0.23	0
TW485	2.3729	64577	77	1.98%	0.0470	0.05	0
TW485	2.3729	64598	98	1.04%	0.0247	0.37	0
WI510	1.2274	6513244	GM	18.76%	0.2303	0.29	0
WI510	1.2274	651445822	MTB	55.74%	0.6842	0.15	0
WI510	1.2274	651585624	TSC	25.50%	0.3130	0.14	0
WI510A	1.1294	645115	115	8.43%	0.0952	0.39	0
WI510A	1.1294	64522	22	0.20%	0.0023	0.04	0
WI510A	1.1294	64555	55	6.22%	0.0702	0.27	0
WI510A	1.1294	64558	58	40.36%	0.4558	0.34	0
WI510A	1.1294	64560	60	6.02%	0.0680	0.26	0
WI510A	1.1294	64580	80	2.81%	0.0317	0.08	0
WI510A	1.1294	6513244	GM	22.49%	0.2540	0.29	0
WI510A	1.1294	651445822	MTB	13.45%	0.1519	0.15	0
WI538	1.4302	64529	29	0.47%	0.0067	0.34	0
WI538	1.4302	6453	3	3.15%	0.0451	0.58	0
WI538	1.4302	64544	44	35.96%	0.5143	0.03	0
WI538	1.4302	64545	45	32.02%	0.4580	0.03	0
WI538	1.4302	64558	58	3.63%	0.0519	0.34	0
WI538	1.4302	64574	74	0.16%	0.0023	0.08	0
WI538	1.4302	64598	98	24.61%	0.3520	0.37	0
WI538A	0.7764	645108	108	5.57%	0.0432	0.31	30
WI538A	0.7764	64544	44	9.09%	0.0706	0.03	0
WI538A	0.7764	64545	45	9.68%	0.0752	0.03	0
WI538A	0.7764	64563	63	7.04%	0.0547	0.14	25
WI538A	0.7764	64574	74	68.33%	0.5305	0.08	0
WI538A	0.7764	64598	98	0.29%	0.0023	0.37	0
WI560	3.5624	645110	110	15.77%	0.5618	0.13	0
WI560	3.5624	645113	113	13.66%	0.4866	0.39	0
WI560	3.5624	645115	115	3.60%	0.1282	0.39	0
WI560	3.5624	64548	48	15.27%	0.5440	0.06	0
WI560	3.5624	64555	55	1.74%	0.0620	0.27	0
WI560	3.5624	64558	58	3.17%	0.1129	0.34	0
WI560	3.5624	64575	75	11.67%	0.4157	0.23	0
WI560	3.5624	64577	77	1.30%	0.0463	0.05	0
WI560	3.5624	64598	98	33.83%	1.2052	0.37	0
WI560A	2.0440	645110	110	0.11%	0.0022	0.13	0
WI560A	2.0440	645113	113	15.41%	0.3150	0.39	0
WI560A	2.0440	645115	115	1.64%	0.0335	0.39	0
WI560A	2.0440	645121	121	4.92%	0.1006	0.12	0
WI560A	2.0440	64533	33	12.68%	0.2592	0.23	0
WI560A	2.0440	64547	47	2.84%	0.0580	0.11	0
WI560A	2.0440	64548	48	10.16%	0.2077	0.06	0
WI560A	2.0440	64562	62	9.07%	0.1854	0.15	0
WI560A	2.0440	64563	63	5.14%	0.1051	0.14	25
WI560A	2.0440	64564	64	21.97%	0.4491	0.14	25
WI560A	2.0440	64574	74	5.36%	0.1096	0.08	0
WI560A	2.0440	64575	75	6.12%	0.1251	0.23	0

APPENDIX D.2.1: Soil Type Summary

Entellus

SHEET		OF	
BY		DATE	4/19/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
WI560A	2.0440	64597	97	4.59%	0.0938	0.07	0
WI576	1.1801	645113	113	5.90%	0.0696	0.39	0
WI576	1.1801	64574	74	0.76%	0.0090	0.08	0
WI576	1.1801	64575	75	59.05%	0.6968	0.23	0
WI576	1.1801	64598	98	34.29%	0.4047	0.37	0
WI576A	1.2238	645112	112	2.04%	0.0250	0.39	0
WI576A	1.2238	645115	115	2.23%	0.0273	0.39	0
WI576A	1.2238	645121	121	7.06%	0.0864	0.12	0
WI576A	1.2238	64538	38	13.94%	0.1706	0.13	0
WI576A	1.2238	64542	42	30.86%	0.3777	0.17	0
WI576A	1.2238	64562	62	12.83%	0.1570	0.15	0
WI576A	1.2238	64563	63	6.32%	0.0773	0.14	25
WI576A	1.2238	64564	64	0.74%	0.0091	0.14	25
WI576A	1.2238	64574	74	15.80%	0.1934	0.08	0
WI576A	1.2238	64594	94	3.16%	0.0387	0.33	0
WI576A	1.2238	64598	98	5.02%	0.0614	0.37	0
WI576B	0.4631	645115	115	31.00%	0.1436	0.39	0
WI576B	0.4631	64574	74	50.50%	0.2339	0.08	0
WI576B	0.4631	64598	98	18.50%	0.0857	0.37	0
WI578	0.4841	645121	121	17.65%	0.0854	0.12	0
WI578	0.4841	64548	48	21.08%	0.1020	0.06	0
WI578	0.4841	64574	74	30.88%	0.1495	0.08	0
WI578	0.4841	64598	98	30.39%	0.1471	0.37	0
WI580	1.3195	645110	110	8.38%	0.1106	0.13	0
WI580	1.3195	645113	113	1.20%	0.0158	0.39	0
WI580	1.3195	64574	74	22.05%	0.2909	0.08	0
WI580	1.3195	64575	75	17.78%	0.2346	0.23	0
WI580	1.3195	64598	98	50.60%	0.6677	0.37	0
WI580A	2.7850	645110	110	1.05%	0.0292	0.13	0
WI580A	2.7850	645112	112	5.03%	0.1401	0.39	0
WI580A	2.7850	645121	121	19.79%	0.5512	0.12	0
WI580A	2.7850	64533	33	1.54%	0.0429	0.23	0
WI580A	2.7850	64538	38	0.97%	0.0270	0.13	0
WI580A	2.7850	64542	42	2.51%	0.0699	0.17	0
WI580A	2.7850	64545	45	2.19%	0.0610	0.03	0
WI580A	2.7850	64562	62	15.09%	0.4203	0.15	0
WI580A	2.7850	64563	63	17.84%	0.4968	0.14	25
WI580A	2.7850	64564	64	0.32%	0.0089	0.14	25
WI580A	2.7850	64574	74	16.46%	0.4584	0.08	0
WI580A	2.7850	64594	94	1.62%	0.0451	0.33	0
WI580A	2.7850	64597	97	8.43%	0.2348	0.07	0
WI580A	2.7850	64598	98	7.14%	0.1988	0.37	0
WI580B	0.6285	645121	121	20.66%	0.1298	0.12	0
WI580B	0.6285	64533	33	31.73%	0.1994	0.23	0
WI580B	0.6285	64562	62	9.59%	0.0603	0.15	0
WI580B	0.6285	64563	63	28.41%	0.1786	0.14	25
WI580B	0.6285	64564	64	7.75%	0.0487	0.14	25
WI580B	0.6285	64574	74	1.85%	0.0116	0.08	0

APPENDIX D.2.1: Soil Type Summary

Entellus

SHEET		OF	
BY		DATE	4/19/2004
CHECK		DATE	

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Areas and percentage area reported to 4 significant digits by WMS. Actual precision of the data is only 2-3 significant digits

Basin ID	Total Basin Area (sq-miles)	Soil Type (WMS)	Soil Type (DDMSW)	Soil Type Area (%)	Soil Type Area (sq-miles)	XKSAT (in/hr)	RTIMP
WT150	1.0865	64510	10	2.93%	0.0318	0.94	0
WT150	1.0865	645100	100	78.45%	0.8524	0.40	20
WT150	1.0865	64548	48	14.85%	0.1613	0.06	0
WT150	1.0865	651285026	EPD	1.26%	0.0137	0.12	0
WT150	1.0865	6515822	TB	2.51%	0.0273	0.40	0
WT150A	4.7510	645100	100	100.00%	4.7510	0.40	20

Yavapai Soil Parameters

XKSAT values for the portion of the Wittmann Area located within Yavapai County were not available. The soil types were identified using the *Soil Survey of Yavapai County, Arizona, Western Part* **(Reference 7).**
XKSAT calculations were based on the procedures outlined in the *Drainage Design Manual for Maricopa County, Arizona, Volume 1-Hydrology* **(Reference 15)**. The six Yavapai County soil types identified in the Wittmann project area are as follows:

CmD
- 5% Rock Outcrop
- 65% Sandy Loam
- 20% Gravelly Sandy Loam
- 10% Clayey Soil

CnF
- 20% Rock Outcrop
- 75% Sandy Loam
- 5% Clay

Le
- 4% Rock Outcrop
- 48% Clay
- 48% Clay Loam

Lh
- 40% Rock Outcrop
- 50% Clay Loam
- 10% Clay

MkF
- 20% Rock Outcrop
- 70% Gravelly Loam
- 10% Gravelly Clay Loam

Rr
- 60% Rock Outcrop
- 40% Clay

Copies of the relevant pages from the Soil Survey are included at the end of this section.

The XKSAT values for the soils were obtained from Table 4.2 (Green and Ampt Loss Rate Parameters for Bare Ground) in *Design Manual for Maricopa County, Arizona, Volume 1-Hydrology* **(Reference 15)**.

Because the XKSAT value is the hydraulic conductivity at natural saturation in inches/hour, Rock Outcrop cannot be included due to its impermeability. The area associated with this impermeable Rock must be excluded from the calculations. This exclusion can be seen in the Final % Soil (Not including Rock Outcrop) column of the following table. Once this is achieved and a relative percentage of each soil type is obtained (excluding Rock Outcrop), the XKSAT can be calculated as:

$$XKSAT = ALOG[\ (\%soil_1 * LOG(XKSAT_1) + \ldots\ (\%soil_x * LOG(XKSAT_x)]$$

Where ALOG is 10 raised to the power of the stack ($\%soil_1 * LOG(XKSAT_1) \ldots$). The results of this are found in the following table.

Table HY-D1. Soil Parameters

CmD

Description	Soil %	Final % Soil (Not including Rock Outcrop)	XKSAT (in/hr)	%*LOG(XKSAT)
Gravelly Sandy Loam *	20.0%	21.1%	0.40	-0.0838
Clay	10.0%	10.5%	0.01	-0.2105
Rock Outcrop	5.0%	0.0%		
Sandy Loam	65.0%	68.4%	0.40	-0.2723
Sum	100.0%	100.0%		-0.5666
			Final XKSAT (in/hr)	0.2713

CnF

Description	Soil %	Final % Soil (Not including Rock Outcrop)	XKSAT (in/hr)	%*LOG(XKSAT)
Rock Outcrop	20.0%	0.0%		
Sandy Loam	75.0%	93.8%	0.40	-0.3731
Clay	5.0%	6.3%	0.01	-0.1250
Sum	100.0%	100.0%		-0.4981
			Final XKSAT (in/hr)	0.3176

Le

Description	Soil %	Final % Soil (Not including Rock Outcrop)	XKSAT (in/hr)	%*LOG(XKSAT)
Rock Outcrop	4.0%	0.0%		
Clay	48.0%	50.0%	0.01	-1.0000
Clay Loam	48.0%	50.0%	0.04	-0.6990
Sum	100.0%	100.0%		-1.6990
			Final XKSAT (in/hr)	0.0200

* Gravelly Sandy Loam was not included in Table 4.2 the closest value (Sandy Loam) was used

Table HY-D.1. Soil Parameters (Cont.)

Lh

Description	Soil %	Final % Soil (Not including Rock Outcrop)	XKSAT (in/hr)	%*LOG(XKSAT)
Rock Outcrop	40.0%	0.0%		
Clay	10.0%	16.7%	0.01	-0.3333
Clay Loam	50.0%	83.3%	0.04	-1.1650
Sum	100.0%	100.0%		-1.4983
			Final XKSAT (in/hr)	0.0317

MkF

Description	Soil %	Final % Soil (Not including Rock Outcrop)	XKSAT (in/hr)	%*LOG(XKSAT)
Gravelly Loam**	70.0%	87.5%	0.25	-0.5268
Gravelly Clay Loam ***	10.0%	12.5%	0.04	-0.1747
Rock Outcrop	20.0%	0.0%		
Sum	100.0%	100.0%		-0.7015
			Final XKSAT (in/hr)	0.1988

Rr

Description	Soil %	Final % Soil (Not including Rock Outcrop)	XKSAT (in/hr)	%*LOG(XKSAT)
Rock Outcrop	60.0%	0.0%		
Clay	40.0%	100.0%	0.01	-2.0000
Sum	100.0%	100.0%	0.00	-2.0000
			Final XKSAT (in/hr)	0.0100

** Gravelly Loam was not included in Table 4.2 the closest value (Loam) was used
* Gravelly Clay Loam was not included in Table 4.2 the closest value (Clay Loam) was used

Recommended Methods for Estimating Rainfall Losses

Drainage Design for Maricopa County, Volume 1–Hydrology (Reference 15)

The three infiltration parameters are functions of soil characteristics, ground surface characteristics, and land management practices. The soil characteristics of interest are particle size distribution (soil texture), organic matter, and bulk density. The primary soil surface characteristics are vegetation canopy cover, ground cover, and soil crusting. The land management practices are identified as various tillages as they result in changes to soil porosity.

Values of Green and Ampt equation parameters as a function of soil characteristics alone (bare ground condition) have been obtained from published reports (Rawls and others, 1983; Rawls and Brakensiek, 1983), and average values of XKSAT and PSIF for each of the soil texture classes are shown in Columns (2) and (3) of Table 4.2. The values of XKSAT and PSIF from Table 4.2 or Figure 4.3 should be used if general soil texture classification of the drainage area is available. References used to create Table 4.2 can be found in the Documentation Manual.

In Table 4.2, loamy sand and sand are combined. The parameter values that are shown in the table are for loamy sand. The hydraulic conductivity (XKSAT) for sand is often used as 4.6 inches/hour, and the capillary suction (PSIF) is often used as 1.9 inches. Using those parameter values for drainage areas can result in the generation of no rainfall excess—which may or may not be correct. Incorrect results could cause serious consequences for flood control planning and design. Therefore, it is recommended *that—for watersheds consisting of relatively small subareas of sand—the* Green and Ampt parameter values for loamy sand be used for the sand portion of the watershed. If the area contains a large portion of sand, then either the Green and

Table 4.2
Green and Ampt Loss Rate Parameter Values for Bare Ground

Soil Texture Classification (1)	XKSAT Inches/hour (2)	PSIF Inches (3)	DTHETA[1]		
			Dry (4)	Normal (5)	Saturated (6)
loamy sand & sand	1.2	2.4	0.35	0.30	0
sandy loam	0.40	4.3	0.35	0.25	0
loam	0.25	3.5	0.35	0.25	0
silty loam	0.15	6.6	0.40	0.25	0
silt	0.10	7.5	0.35	0.15	0
sandy clay loam	0.06	8.6	0.25	0.15	0
clay loam	0.04	8.2	0.25	0.15	0
silty clay loam	0.04	10.8	0.30	0.15	0
sandy clay	0.02	9.4	0.20	0.10	0
silty clay	0.02	11.5	0.20	0.10	0
clay	0.01	12.4	0.15	0.05	0

[1] Selection of DTHETA:

Dry = Nonirrigated lands, such as desert and rangeland;
Normal = Irrigated lawn, turf, and permanent pasture;
Saturated = Irrigated agricultural land.

fans. The Continental soil is on ridgetops and has more gentle slopes.

Included with these soils in mapping are areas of cobbly Cave soils and exposures of tuff or agglomerate along steep drainageways. Also included are areas of Anthony gravelly sandy loam in the drainageways. These included soils make up about 10 percent of the acreage.

Runoff is medium on these soils. The hazard of erosion is moderate.

These soils are used for range, wildlife habitat, mining, and watershed catchment areas. Both parts in capability unit VIIe–1. Cave part in Caliche Upland range site, 8- to 12-inch precipitation zone; Continental part in Loam Upland range site, 8- to 12-inch precipitation zone. Cave part in wildlife group 3; Continental part in wildlife group 2.

Cellar Series

The Cellar series consists of well-drained soils that are shallow and very shallow over granite. These soils are on gently sloping to steep granite hills and mountains. Slopes range from 2 to 60 percent. Elevation ranges from 2,000 to 4,500 feet. The vegetation is desert shrubs and cactuses and an understory of grass. Annual precipitation is 8 to 12 inches. The average annual air temperature is 57° to 69° F, and the frost-free period is 180 to 270 days.

In a representative profile the surface layer is pale-brown very stony sandy loam about 1 inch thick. The underlying layer is brown very gravelly loam about 7 inches thick. It is underlain by granite that is weathered or fractured in places.

Permeability is moderately rapid. Available water capacity is low, and the effective rooting depth is less than 20 inches.

These soils are used mainly for seasonal range, wildlife habitat, mining, and watershed catchment areas.

Representative profile of Cellar very stony sandy loam in an area of Cellar very gravelly sandy loam, 8 to 30 percent slopes, near Merritt Pass, approximately 0.4 mile NW. of the SE. corner, sec. 8, T. 7 N., R. 2 W.:

A1—0 to 1 inch, pale-brown (10YR 6/3) very stony sandy loam, brown (10YR 4/3) when moist; weak, thin and medium, platy structure; slightly hard when dry, friable when moist, nonsticky and slightly plastic when wet; common very fine roots; few fine tubular pores and common fine interstitial pores; moderately alkaline; abrupt, smooth boundary.

C—1 to 8 inches, brown (7.5YR 5/4) very gravelly heavy loam, dark brown (7.5YR 4/4) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine and fine roots; common fine tubular pores and many fine interstitial pores; moderately alkaline; abrupt, irregular boundary.

R—8 to 9 inches, white (N 8/0) granite, stained with few thin yellowish-red (5YR 4/6) coatings; noneffervescent to slightly effervescent in spots.

Depth to granite ranges from 4 to 15 inches but is generally about 8 inches. The soils range from noneffervescent to strongly effervescent and in reaction from neutral to moderately alkaline. Content of coarse fragments averages more than 50 percent.

In the A horizon hue is 10YR or 7.5YR, value is 5 or 6 dry and 3 or 4 moist, and chroma is 3 or 4. The A horizon is gravelly or very gravelly sandy loam, cobbly or very cobbly sandy loam, very stony sandy loam, or gravelly loamy sand.

In the C horizon hue is 7.5YR or 10YR, value is 4 to 6 dry and 3 or 4 moist, and chroma is 4 to 6. The C horizon ranges from very gravelly sandy loam or very gravelly heavy loam to cobbly or very cobbly and very stony sandy loam.

Cellar very gravelly sandy loam, 8 to 30 percent slopes (CnD).—This soil is on granite or schist hills that are dissected by a few long extended drainageways and numerous short drainageways. The profile described as representative of the series is in an area of this soil.

Included with this soil in mapping, and making up about 10 percent of the acreage, are small areas of a clayey soil that is shallow over schist, and some very rocky and cobbly Cellar soils. Also included, and making up about 20 percent of the acreage, are areas of Cellar very gravelly sandy loam that has 30 to 60 percent slopes.

Runoff is medium on this soil. The hazard of erosion is moderate.

This soil is used for seasonal range, wildlife habitat, mining, and watershed catchment areas. Capability unit VIIs–1; Loam Hills range site, 8- to 12-inch precipitation zone; wildlife group 4.

Cellar very rocky sandy loam, 2 to 15 percent slopes (CnC).—This soil is on low granite hills that are dissected by numerous short drainageways. It has a profile similar to the one described as representative of the series, but it is gently sloping to strongly sloping, and rock outcrops make up about 20 percent of the acreage. Included in mapping, and making up about 10 percent of the acreage, are areas of Chiricahua gravelly sandy loam that has 2 to 8 percent slopes.

Runoff is slow on this soil. The hazard of erosion is slight.

This soil is used for seasonal grazing, wildlife habitat, mining, and watershed catchment areas. Capability unit VIIs–1; Loam Hills range site, 8- to 12-inch precipitation zone; wildlife group 4.

Cellar very rocky sandy loam, 15 to 60 percent slopes (CnE).—This soil is on hills and mountains that are dissected by numerous short drainageways. It has a profile similar to the one described as representative of the series, but the surface has numerous rock outcrops. These outcrops make up about 20 percent of the acreage. Included in mapping, and making up about 10 percent of the acreage, are areas of Chiricahua gravelly sandy loam that has 15 to 30 percent slopes.

Runoff is medium to rapid on this soil. The hazard of erosion is moderate to high.

This soil is used for seasonal grazing, wildlife habitat, mining, and watershed catchment areas. Capability unit VIIs–1; Loam Hills range site, 8- to 12-inch precipitation zone; wildlife group 4.

Cellar-Chiricahua complex, 8 to 30 percent slopes (CoD).—This complex is about 60 percent Cellar gravelly and very stony sandy loams that have slopes of 8 to 30 percent and about 25 percent Chiricahua gravelly and very stony sandy loams that have slopes of 8 to 15 percent. One of the Chiricahua soils has the profile described as representative of the Chiricahua series.

Included with these soils in mapping, and making up

hard lime concretions; moderately alkaline; clear, broken boundary.

C3ca—43 to 50 inches, stratified white (N 8/0) and pinkish-gray (7.5YR 7/2) gravelly sandy loam, pink (7.5YR 7/4) and dark brown (7.5YR 4/4) when moist; massive; very hard when dry, firm when moist, nonsticky and nonplastic when wet; few fine tubular pores; violently effervescent.

Depth to the Cca horizon ranges from 14 to 30 inches. In the A1 horizon hue is 7.5YR or 10YR, value is 5 to 7 dry and 4 or 5 moist, and chroma is 2 to 4. The A1 horizon is dominantly gravelly sandy loam and sandy loam. Content of lime nodules in the surface layer ranges from few to none.

In the C1 and C2ca horizons hue is dominantly 7.5YR or 10YR, value is 5 to 8 dry and 4 to 7 moist, and chroma is 2 to 4. The C1 and C2 horizons are fine sandy loam, loam, or silt loam. In some places the Cca horizon extends to a depth of 6 feet or more and has limy, but less nodular, material below a depth of 3 feet. The Cca horizon is weakly cemented in places. Size and content of lime nodules in the Cca horizon varies from few, fine to many, medium and coarse.

Latene gravelly sandy loam (Lc).—This nearly level to gently sloping soil is on alluvial fans or plains that are dissected by numerous long shallow drainageways. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Anthony and Mohave sandy loams on the fan tops and Vekol loam in swales. These included soils make up about 10 percent of the acreage.

Runoff is slow on this soil. The hazard of erosion is slight.

This soil is used mainly for range, wildlife habitat, and watershed catchment areas. Capability unit VIIc–1; Loam Upland range site, 8- to 12-inch precipitation zone; wildlife group 2.

Latene-Mohave complex (Lc).—This complex is about 55 percent Latene gravelly sandy loam and 35 percent Mohave sandy loam. These soils are in an intricate pattern on nearly level to undulating fans. The Latene soil is on low ridgetops or higher lying areas, and the Mohave soil is on side slopes and in swales where slopes generally are less than 3 percent.

Included with these soils in mapping, and making up about 10 percent of the acreage, are small areas of Anthony sandy loam and narrow areas of Vekol loam. The Anthony soil is on the fan tops and the Vekol soil is in swales.

Runoff is slow on these soils. The hazard of erosion is slight.

These soils are used for range, wildlife habitat, and watershed catchment areas. Capability unit VIIc–1; Loam Upland range site, 8- to 12-inch precipitation zone; wildlife group 2.

Lehmans Series

The Lehmans series consists of shallow, well-drained soils that are underlain by bedrock at a depth of 10 to 20 inches. These soils formed in material weathered from andesite or related tuff and agglomerate. They are in areas where there are moderately sloping to very steep hills or mountains. Slopes range from 8 to 60 percent. Elevation ranges from 1,800 to 4,000 feet. The vegetation is desert shrubs and cactuses and an understory of scattered grasses. Annual precipitation is 8 to 11 inches. The average annual air temperature is about 65° F, and the frost-free period is 200 to 25 days.

In a representative profile the surface layer is brow gravelly clay loam about 1 inch thick. The subsoil i reddish-brown and brown gravelly clay and clay abou 13 inches thick. It is underlain by pale-red extremel hard andesite or tuffaceous agglomerate.

Permeability is slow. Available water capacity i low, and the effective rooting depth is less than 2 inches.

These soils are used mainly for seasonal grazing mining, wildlife habitat, and watershed catchmen areas.

Representative profile of Lehmans gravelly cla loam, 8 to 45 percent slopes, 0.24 mile S. and 0.12 mil E. of the NW. corner, sec. 22, T. 8 N., R. 1 W.:

A1—0 to 1 inch, brown (7.5YR 5/2) gravelly clay loam, dar brown (7.5YR 3/2) when moist; moderate, fine granular structure; slightly hard when dry, friabl when moist, sticky and plastic when wet; commo fine roots; many fine interstitial pores; moderatel alkaline; abrupt, wavy boundary.

B21t—1 to 8 inches, reddish-brown (5YR 5/3) gravelly clay reddish brown (5YR 4/4) when moist; moderate medium and fine, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; common very fine and few coarse roots; few fine tubular pores and common fine interstitial pores; many thin clay films on ped faces and in pores; neutral; clear, wavy boundary.

B22t—8 to 14 inches, brown (7.5YR 5/4) light clay, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; common very fine roots; very few fine tubular pores and common fine interstitial pores; common thin clay films on ped faces and in pores; neutral; abrupt, wavy boundary.

R—14 to 16 inches, pale-red (10R 6/4), reddish-gray (10R 5/1), and red (10R 5/6) massive, extremely hard andesite.

Depth to bedrock ranges from 10 to 20 inches but is dominantly 14 to 18 inches. Coarse fragments range from gravel to stone size and from 10 to 30 percent by volume.

In the A horizon hue is 10YR to 5YR but is dominantly 7.5YR. Value is 4 to 6 dry and 3 or 4 moist. Chroma is 2 to 6. In the B2t horizon hue is 7.5YR to 2.5YR but is dominantly 5YR and 7.5YR. Value is 4 or 5 dry and 3 to 5 moist. Chroma is 3 to 6. The B2t horizon is gravelly heavy clay loam, clay, and gravelly clay.

Lehmans gravelly clay loam, 8 to 45 percent slopes (Lh).—This soil is on andesite, tuff, or agglomerate hills and mountains that are dissected by numerous steep-sided drainageways. It has the profile described as representative of the series.

Included with this soil in mapping are areas where rock outcrops and stones are common. Also included are deep, colluvial soils on the lower parts of side slopes and coarse-textured alluvial soils in the drainageways. These included soils make up about 10 percent of the acreage.

Runoff is medium on this soil. The hazard of erosion is moderate.

This soil is used for range, wildlife habitat, mining, and watershed catchment areas. Capability unit VIIe–1; Loam Hills range site, 8- to 12-inch precipitation zone; wildlife group 4.

[illegible] Extremely Rocky Clay Loam, 8 to 60 Percent Slopes.—This soil is on andesite, tuff, or agglomerate [illegible]s and mountains that are dissected by numerous short drainageways and a few long drainageways that have steep sides. About 40 percent of the acreage is rock outcrops and exposures of tuff and agglomerate.

Included with these soils in mapping, and making up about 10 percent of the acreage, are deep colluvial soils on the lower parts of side slopes and coarse-textured alluvial soils in the drainageways.

Runoff is medium to rapid on these soils. The hazard of erosion is moderate to high.

These soils are used for range, wildlife habitat, mining, and watershed catchment areas. Capability unit VIIs–1; Loam Hills range site, 8- to 12-inch precipitation zone, wildlife group 4.

Loamy Alluvial Land

Loamy alluvial land consists of stratified, gravelly, medium-textured soils that are underlain by moderate to shallow, stratified gravelly loamy sand and sand. This material is in and adjacent to shallow drainageways. The alluvium weathered from a wide variety of rocks but is dominantly acid igneous material. Areas are rarely flooded, and then only for short periods.

Permeability is moderate. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more.

This land type is used for limited grazing, wildlife habitat, and watershed.

This land type is mapped only in association with [illegible]tinental soils. Capability unit VIIw–1; Loam Bottoms range site, 8- to 12-inch precipitation zone; wildlife group 1.

Lonti Series

The Lonti series consists of deep, well-drained soils. These soils formed in mixed alluvium weathered from granite, schist, basalt, and sandstone. Lonti soils are on nearly level plains to very steep alluvial fans. Slopes range from 0 to 60 percent. Elevation ranges from 4,000 to 5,500 feet. The vegetation is grass, brush, and some pinyon pine and juniper at higher elevations. Annual precipitation is 12 to 20 inches. The average annual air temperature is 52° to 57° F, and the frost-free period is 140 to 200 days.

In a representative profile the surface layer is grayish-brown gravelly sandy loam about 2 inches thick. The subsoil is dark-brown gravelly sandy clay loam and reddish-brown gravelly clay and gravelly clay loam about 43 inches thick. The substratum is pink and light reddish-brown gravelly sandy clay loam to a depth of 68 inches or more.

Permeability is slow. Available water capacity is high, and the effective rooting depth is more than 60 inches.

These soils are used mainly for range, wildlife habitat, recreation, and watershed catchment areas. Limited acreages of Lonti soils are used for irrigated crops in the Chino Valley area. Small areas have been sub[illegible]ed for use as homesites and for small commercial [illegible]dings.

Representative profile of Lonti gravelly sandy loam, 0 to 8 percent slopes, from an area of Lonti-Abra gravelly sandy loams, 0 to 8 percent slopes, 0.5 mile W. and 0.3 mile N. of the SE. corner, sec. 3, T. 15 N., R. 4 W.:

A1—0 to 2 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and thick, platy structure; slightly hard when dry, very friable when moist; slightly sticky and slightly plastic when wet; common very fine and fine roots; many very fine and fine vesicular pores; neutral; clear, wavy boundary.

B1t—2 to 5 inches, dark-brown (10YR 3/3) dry and moist, gravelly sandy clay loam; moderate, very fine and fine, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many very fine and fine roots; many fine and very fine interstitial pores and common very fine and fine tubular pores; few thin clay films on ped faces; neutral; clear, wavy boundary.

B21t—5 to 10 inches, reddish-brown (5YR 4/3) gravelly light clay, reddish brown (5YR 4/4) when moist; weak, fine and medium, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many very fine and fine roots; common fine interstitial pores; common thin clay films on ped faces; slightly acid; clear, smooth boundary.

B22t—10 to 26 inches, reddish-brown (5YR 4/4) gravelly light clay, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common fine and medium roots; common very fine and fine tubular pores and many fine interstitial pores; common moderately thick clay films on ped faces; many pressure faces; slightly acid; clear, wavy boundary.

B3t—26 to 45 inches, reddish-brown (5YR 5/4) gravelly clay loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few fine and very fine roots; few very fine and fine tubular pores and common fine interstitial pores; common moderately thick clay films on ped faces; common pressure faces; moderately alkaline; gradual, wavy boundary.

C1ca—45 to 55 inches, pink (5YR 7/3) gravelly sandy clay loam, yellowish red (5YR 5/6) when moist; massive; very hard when dry, firm when moist, slightly sticky and plastic when wet; few fine and very fine roots; very few fine tubular pores and common fine interstitial pores; few pressure faces; slightly effervescent in matrix but violently effervescent in common, medium, prominent, white (10YR 8/1), soft lime segregations; moderately alkaline; gradual, irregular boundary.

C2ca—55 to 68 inches, light reddish-brown (5YR 6/4) very gravelly sandy clay loam, reddish brown (5YR 5/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few fine roots; common fine tubular pores and many interstitial pores; noneffervescent in matrix but strongly effervescent in common, medium, prominent, white (10YR 8/1), soft lime segregations; moderately alkaline.

Depth to the Cca horizon ranges from 18 to 45 inches. Content of coarse fragments averages from 15 to 35 percent by volume. Reaction ranges from slightly acid to neutral in the A1 and B1t horizons, from slightly acid to moderately alkaline in the B2t horizon, and from mildly alkaline to moderately alkaline in the B3t and Cca horizons.

In the A and B1t horizons, hue ranges from 5YR to 10YR but is dominantly 7.5YR or 10YR. Value is 3 to 5 dry and 3 or 4 moist. The A horizon is gravelly sandy loam, sandy loam, gravelly loam, and cobbly loam.

In the B2t horizon hue is 5YR or 7.5YR, value is 4 and 5 dry, and chroma is 3 to 6. The B2t horizon is heavy clay loam, gravelly clay loam, clay, and gravelly clay. Structure of the

Runoff is medium to rapid on this soil. The hazard of erosion is moderate to high.

This soil is used for trees, wildlife habitat, recreation, mining, and watershed catchment areas. Capability unit VIe–2; timber group 1; wildlife group 11.

Mirabal gravelly sandy loam, 20 to 60 percent slopes (MbF).—This soil is on mountainous areas that are dissected by numerous short drainageways and a few long drainageways. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 20 percent of the acreage, are areas of Dandrea gravelly loam, areas of rock outcrops, and narrow areas of coarse-textured, recent alluvial soils in the drainageways.

Runoff is rapid on this soil. The hazard of erosion is high.

This soil is used for trees, wildlife habitat, recreation, mining, and watershed catchment areas. Capability unit VIIe–2; timber group 1; wildlife group 11.

Mirabal-Dandrea complex, 20 to 60 percent slopes (MdF).—This complex is about 55 percent Mirabal gravelly sandy loam and 35 percent Dandrea gravelly loam. These soils are in an intricate pattern on moderately steep to very steep hills and mountains that are dissected by numerous short drainageways and a few long drainageways.

Included with these soils in mapping, and making up about 10 percent of the acreage, are areas of rock outcrops, very stony areas, areas of Mirabel gravelly sandy loam, and areas of Dandrea gravelly sandy loam that has slopes of 8 to 15 percent.

Runoff is medium on these soils. The hazard of erosion is high.

These soils are used for trees, wildlife habitat, recreation, mining, and watershed catchment areas. Both parts in capability unit VII–2. Mirabal part in timber group 1; Dandrea part in timber group 1. Both parts in wildlife group 11.

Moano Series

The Moano series consists of well-drained soils that are very shallow and shallow over schist. These soils formed in place on gently sloping to very steep hills. Slopes range from 0 to 60 percent. Elevation ranges from 4,000 to 5,500 feet. The vegetation at higher elevations is brush and an understory of grass. At the lower elevations grasses are dominant. Annual precipitation is 12 to 16 inches. The average annual air temperature is 50° to 57° F, and the frost-free period is 140 to 200 days.

In a representative profile the surface layer is brown gravelly loam about 3 inches thick. The next layer is brown gravelly heavy loam about 6 inches thick. It is underlain by olive-brown schist.

Permeability is moderate. Available water capacity is low, and the effective rooting depth is less than 20 inches.

These soils are used mainly for range, wildlife habitat, mining; and watershed catchment areas. The underlying rock is used for building stone in limited amounts.

Representative profile of Moano gravelly loam, (30 percent slopes, 0.2 mile E. and 0.1 mile S. of the N corner, sec. 23, T. 12 N., R. 1 E.:

A1—0 to 3 inches, brown (7.5YR 4/4) gravelly loam, (brown (7.5YR 3/2) when moist; moderate, very and fine, granular structure; soft when dry, fri when moist, slightly sticky and slightly pla when wet; common very fine and fine roots; m fine interstitial pores; neutral; clear, irreg boundary.

C—3 to 9 inches, brown (7.5YR 4/4) gravelly heavy lo brown (7.5YR 4/4) when moist; massive; sligl hard when dry, friable when moist, slightly sti and plastic when wet; many fine and medium few coarse roots; many fine interstitial pores; m erately alkaline; clear, irregular boundary.

R1—9 to 14 inches, olive (5Y 4/4) to olive-brown (2.5Y 4/ hard, slightly weathered schist.

R2—14 to 16 inches, pale-yellow (2.5YR 7/4), extrem hard schist.

Depth to bedrock ranges from 6 to 20 inches but genera is 6 to 16 inches. Because of the variability of parent r reaction ranges from slightly acid to moderately alkal throughout.

In the A horizon hue is 10YR or 7.5YR, value is 4 or 5 (and 3 or 4 moist, and chroma is 2 to 4. The A horizon gravelly loam or very gravelly loam. Structure of the horizon ranges from platy to granular.

In the C horizon hue is 10YR to 5YR, value is 4 to 6 (and 3 or 4 moist, and chroma is 4 to 6. The C horizon gravelly loam or gravelly light clay loam. Content of gra in the C horizon ranges from 15 to 35 percent by volume

Moano gravelly loam, 0 to 30 percent slopes (MgD).- This soil is on hills that are dissected by numerous sho drainageways and a few long drainageways. It has t profile described as representative of the series.

Included with this soil in mapping, and making about 15 percent of the acreage, are small areas of A gravelly clay loam that has slopes of 0 to 15 perce and areas of Lynx loam in the drainageways.

Runoff is medium to rapid on this soil. The haza of erosion is moderate.

This soil is used for range, wildlife habitat, minin and watershed catchment areas. Capability unit VII 1; Granitic Loam Hills range site, 12- to 16-inch pr cipitation zone; wildlife group 5.

Moano very rocky loam, 15 to 60 percent slopes (Mk —This complex is about 70 percent Moano gravel loam and 20 percent rock outcrops. This complex is moderately steep and very steep hills and mountai that are dissected by numerous short drainageways.

Included with this soil in mapping, and making about 10 percent of the acreage, are small areas of A gravelly clay loam that has slopes of 8 to 30 perce and narrow areas of Lynx soils in the drainageways.

Runoff is rapid. The hazard of erosion is modera to high.

This soil is used for range, wildlife habitat, minin and watershed catchment areas. Capability un VIIs–1; Granitic Loam Hills range site, 12- to 16-inc precipitation zone; wildlife group 5.

Moano extremely rocky loam, 15 to 30 percent slop (MoD).—This complex is about 60 percent Moano gravell loam and about 30 percent rock outcrops. It is o strongly sloping and moderately steep hills that a dissected by numerous short drainageways.

Included with this soil in mapping, and making about 10 percent of the acreage, are small areas of Ar

range from few to many. Secondary calcium carbonate and lime nodules are present in places immediately above the parent rock. Cracks that are 2 inches or more wide and 20 to 36 inches deep are common if the soil is dry.

In the A1 horizon hue is 2.5YR to 7.5YR, value is 4 or 5 dry and 2 to 4 moist, and chroma is 2 to 4. The A horizon is clay, silty clay, heavy silty clay loam, or clay loam, all of which are modified by coarse fragments. In the C horizon hue is 7.5YR to 2.5YR, value is 3 to 5 dry and 2 to 4 moist, and chroma is 2 to 4. The C horizon is clay or silty clay.

Rimrock cobbly clay (Rk).—This nearly level to undulating soil is on basalt plains. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 10 percent of the acreage, are areas of Rimrock gravelly clay loam, Rimrock very stony clay, Graham gravelly clay loam, and Cave gravelly sandy loam.

Runoff is very slow on this soil. The hazard of erosion is slight.

This soil is used for range, wildlife habitat, and watershed catchment areas. Capability unit VIIs–1; Loam Hills range site, 8- to 12-inch precipitation zone; wildlife group 4.

Rimrock-Cave complex (Rm).—This complex is about 60 percent Rimrock cobbly clay and 30 percent Cave gravelly sandy loam. These soils are in an intricate pattern on nearly level to gently sloping basalt plains and mesa tops. The Cave soil has slopes of less than 5 percent.

Included with these soils in mapping are small areas of rock outcrops, areas of Rimrock very stony clay, and areas of Rimrock cobbly clay that has slopes of 8 to 15 percent. Also included are narrow areas of clay loam alluvial soils in drainageways. These included soils make up about 10 percent of the acreage.

Runoff is very slow and slow on these soils. The hazard of erosion is slight.

These soils are used for range, wildlife habitat, and watershed catchment areas. Both parts in capability unit VIIs–1. Rimrock part in Loam Hills range site, 8- to 12-inch precipitation zone; Cave part in Caliche Upland range site, 8- to 12-inch precipitation zone. Rimrock part in wildlife group 4; Cave part in wildlife group 3.

Rimrock-Graham complex, 3 to 15 percent slopes (Rn). This complex is about 60 percent Rimrock cobbly clay that has slopes of 0 to 8 percent and 30 percent Graham very stony clay loam that has slopes of 8 to 15 percent. These soils are in an intricate pattern on gently to strongly sloping basalt plains that are dissected by a few deep drainageways that have steep sides. The Graham soil is on low ridges and slightly higher lying areas, or near the edges of steep drainageways

Included with these soils in mapping are small areas of Rimrock gravelly clay loam and Graham very stony clay loam that has slopes of 0 to 8 percent. Also included are areas of House Mountain very rocky and gravelly loam and rock outcrops in the Graham soil. These included areas make up about 10 percent of the acreage.

Runoff is slow to medium on these soils. The hazard of erosion is slight to moderate.

These soils are used for range, wildlife habitat, and watershed catchment areas. Capability unit VIIe–1; Loam Hills range site, 8- to 12-inch precipitation zone; wildlife group 4.

Rock Land

Rock land (Ro) consists of 50 to 90 percent rock outcrops, and the rest is shallow and very shallow soils. It is gently rolling and steep on hills, mountains, and divides that are dissected by numerous drainageways and vertical escarpments. The rock outcrops are granite, basalt, limestone, sandstone, or tuff.

Runoff is medium to high. The hazard of erosion is slight.

The vegetation is grass, chaparral, or juniper. Forage production is limited because of the rock outcrops and shallow and very shallow soil depth (fig. 8). Capability unit VIIs–1.

Rock Land, Low Rainfall

Rock land, low rainfall (Rr) consists of 50 to 90 percent rock outcrops, and the rest is shallow and very shallow soils. It is in desert areas and is gently sloping to steep on hills, mountains, and divides that are dissected by numerous drainageways and vertical escarpments. The rock outcrops are basalt, andesite, granite, or tuff. Annual precipitation is less than 12 inches.

Runoff is medium to high. The hazard of erosion is slight.

The vegetation is a sparse cover of desert shrubs and an understory that is dominantly annual grasses. Forage production is severely limited because of the rock outcrops, limited rainfall, and shallow and very shallow depth to bedrock. Capability unit VIIs–1.

Rough Broken Land

Rough broken land (Rs) consists of very shallow to deep soils and soil materials that range from sandy loam to clay loam and are generally calcareous. It is moderately steep and very steep on fans that are highly dissected by numerous steep-sided drainageways. Slopes are highly variable but are dominantly 15 to 60 percent. The soils and soil materials are variable because of the wide variety of materials that form the fans. The surface layer in some areas is gravelly. Soil slipping is common. Tuffaceous material is exposed along some of the drainageways. Geologic erosion is active.

Included with this land type in mapping are small areas of Lonti gravelly loam and similar soils that appear to be remnants of old surfaces.

Runoff is rapid. The hazard of erosion is high.

This land type is used for limited grazing, wildlife habitat, and watershed catchment areas. Capability unit VIIe–1.

Rune Series

The Rune series consists of deep, well-drained soils. These soils formed in mixed alluvium that weathered from shale, limestone, sandstone, and basalt. They are

D.2.2. Land Use

Land Use Description

Existing Land Use

Future Land Use

Municipalities' Land Use Plans

Entellus

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

SHEET _____ OF _____

BY AMG DATE 4/19/2004

CHECK _____ DATE _____

JOB NO. 310.032

Land Use Descriptions

Land Use ID	WMS ID	Land Use Description	IA(inches)	RTIMP(%)	VEG (%)	DTHETA
AGR	750	Agriculture	0.50	0	85	normal
COM-1	200	General Commercial (Commercial where no detail available)	0.10	80	60	normal
COM-2	210	Specialty Commercial (<=50,000 sq. ft.)	0.10	80	65	normal
COM-3	220	Neighborhood Commercial (50,000 to 100,000 sq. ft.)	0.10	80	65	normal
COM-4	230	Community Commercial (100,000 to 500,000 sq. ft.)	0.10	80	75	normal
COM-5	240	Regional Commercial (500,000 to 1,000,000 sq. ft.)	0.10	80	65	normal
COM-6	250	Super-Regional Commercial (>= 1,000,000 sq. ft.)	0.10	80	70	normal
COM-7	510	Tourist and Visitor Accommodations (Hotels, motels and resorts)	0.10	80	75	normal
COM-8	560	Special Events (Includes stadiums, sports complexes and fairgrounds)	0.10	80	75	normal
FWY-1	600	General Transportation (Transportation where no detail available)	0.30	20	30	normal
FWY-2	610	Transportation (Includes railroads, railyards, transit centers and freeways)	0.10	80	30	normal
HDR	180	High Density Residential - Multi Family (10-15 du per acre)	0.25	65	50	normal
IND-1	300	General Industrial (Industrial where no detail available)	0.15	55	60	normal
IND-2	310	Warehouse/Distribution Centers	0.15	80	75	normal
IND-3	320	Industrial	0.15	55	60	normal
IND-4	570	Other Employment - low (Proving grounds and land fills)	0.15	80	25	dry
IND-5	580	Other Employment - medium	0.15	80	75	normal
IND-6	590	Other Employment - high	0.15	80	75	normal
INS-1	520	Educational (Public schools, private schools and universities)	0.25	45	80	normal
INS-2	530	Institutional (Includes hospitals and churches)	0.10	80	75	normal
INS-3	540	Cemeteries	0.20	5	90	normal
INS-4	550	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)	0.10	80	75	normal
LDR-1	120	Estate Residential (1/5 du per acre to 1 du per acre)	0.30	10	30	normal
LDR-2	130	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)	0.30	15	50	normal
MDR-1	140	Medium Lot Residential - Single Family (2-4 du per acre)	0.25	30	50	normal
MDR-2	170	Medium Density Residential - Muli Family (5-10 du per acre)	0.25	45	50	normal
OPEN-1	700	General Open Space (Open space where no detail available)	0.35	5	30	normal
OPEN-2	710	Active Open Space (Includes parks)	0.20	5	50	normal
OPEN-3	720	Golf courses	0.20	5	75	normal
OPEN-4	730	Passive Open Space (Includes mountain preserves and washes)	0.35	0	30	dry
OPEN-5	760	Graded Land	0.25	0	0	dry
SLR	150	Small Lot Residential - Single Family (4-6 du per acre)	0.25	35	50	normal
VAC	900	Vacant (Existing land use database only)	0.35	0	25	dry
VHDR	190	Very High Density Residential - Multi Family (> 15 du per acre)	0.25	85	50	normal
VLDR	110	Rural Residential (<= 1/5 du per acre)	0.30	5	30	dry
VSLR	160	Very Small Lot Residential - Single Family (>6 du per acre-includes mobile home	0.25	40	50	normal
WTR	740	Water	0.00	0	0	wet

Table 4.2
IA, *RTIMP*, AND VEGETATIVE COVER DENSITY FOR REPRESENTATIVE LAND USES IN MARICOPA COUNTY

Land Use[1] Code	Land Use Category	Description	IA[2] inches	RTIMP[2,3] %	Vegetation Cover[2,4] %
VLDR	Very Low Density Residential[3]	40,000 sq. feet and greater lot size	0.30	5	30
LDR	Low Density Residential[3]	12,000 – 40,000 sq. feet lot size	0.30	15	50
MDR	Medium Density Residential[3]	6,000 – 12,000 sq. feet lot size	0.25	30	50
MFR	Multiple Family Residential[3]	1,000 – 6,000 sq. feet lot size (# du/ac)	0.25	45	50
I1	Industrial 1[3]	Light and General	0.15	55	60
I2	Industrial 2[3]	General and Heavy	0.15	55	60
C1	Commercial 1[3]	Light, Neighborhood, Residential	0.10	80	75
C2	Commercial 2[3]	Central, General, Office, Intermediate	0.10	80	75
P	Pavement and Rooftops	Asphalt and Concrete, Sloped Rooftops	0.05	95	0
GR	Gravel Roadways & Shoulders	Graded and Compacted, Treated and Untreated	0.10	5	0
AG	Agricultural	Tilled Fields, Irrigated Pastures, slopes < 1%	0.50	0	85
LPC	Lawns/Parks/Cemeteries	Over 80% maintained lawn	0.20	Varies[5]	80
DL1	Desert Landscaping 1	Landscaping with impervious under treatment	0.10	95	30
DL2	Desert Landscaping 2	Landscaping without impervious under treatment	0.20	0	30
NDR	Undeveloped Desert Rangeland	Little topographic relief, slopes < 5%	0.35	Varies[5]	Varies[6]
NHS	Hillslopes, Sonoran Desert	Moderate topographic relief, slopes > 5%	0.15	Varies[5]	Varies[6]
NMT	Mountain Terrain	High topographic relief, slopes > 10%	0.25	Varies[5]	Varies[6]

Notes:
1. Other land use or zoning classifications, such as Planned Area Development and Schools must be evaluated on a case by case basis.
2. These values have been selected to fit many typical settings in Maricopa County; however, the engineer/hydrologist should always evaluate the specific circumstances in any particular watershed for hydrologic variations from these typical values.
3. RTIMP = Percent Effective Impervious Area, including right-of-way. Effective means that all impervious areas are assumed to be hydraulically connected. The RTIMP values may need to be adjusted based on an evaluation of hydraulic connectivity.
4. Vegetation Cover = Percent vegetation cover for pervious areas only.
5. RTIMP values must be estimated on a case by case basis.
6. Vegetation Cover values must be estimated on a case by case basis.

Table 4.2a IA, RTIMP, and Percent Vegetation Cover for Representative Land Uses in Maricopa County

Land Use Category	IA (inches)	RTIMP ** (percent)	Percent ** Veg. Cover	Gilbert Zoning Unit	Gilbert Description	Chandler Zoning Unit	Chandler Description	Mesa Zoning Unit	Mesa Description	Tempe Zoning Unit	Tempe Description	County Zoning Unit	County Description	Phoenix Zoning Unit	Phoenix Description
Agriculture	0.5*	0*	85*	AG	Agriculture	AG-1	Agriculture	AG	Agriculture	AG	Agriculture				
Very Low Density Residential	0.3*	5*	30*					R1-90	Single Residence			RURAL-190	190,000 sq. ft./dwelling unit	S-1	Ranch or Farm Residential, > 1 acre
								SR	Suburban Ranch			RURAL-70	70,000 sq. ft./dwelling unit	S-2	Ranch or Farm Commercial
				R1-43	Rural							RURAL-43	one acre/dwelling unit	RE-43	Single Family, 1 acre minimum
Low Density Residential	0.3*	15*	50*	R1-35	Rural Residential	SF-33	Single Family	R1-35	Single Residence			R1-35	Single Family Residential, 35,000 sq. ft./dwelling unit	RE-35	SF, 35,000 sq.ft min.
				R1-20	SF, Residential	SF-18	Single Family							RE-24	SF, 24,000 sq.ft min.
				R1-15	" "			R1-15	Single Residence	R1-15	One Family Residential	R1-18	SFR, 18,000 sq. ft./unit	R1-18	SF, 18,000 sq.ft min.
Medium Density Residential	0.25*	30*	50*	R1-10	" "	SF-10	Single Family	R1-9	Single Residence	R1-10	One Family Residential	R1-10	SFR, 10,000 sq. ft./unit	R1-14	SF, 14,000 sq.ft min.
				R1-8	" "					R1-8	One Family Residential			R1-10	SF, 10,000 sq.ft min.
				R1-7	" "	SF-7	Single Family	R1-7	Single Residence	R1-7	One Family Residential	R1-8	SFR, 8,000 sq. ft./unit	R1-8	SF, 8,000 sq.ft min.
								R1-6	Single Residence	R1-6	One Family Residential	R1-6	SFR, 6,000 sq. ft./unit	R1-6	SF, 6,000 sq.ft min.
								TCR-1	Town Center, Single Family	RO	Residence/Office			R-O	Res. Office
Multiple Family Residential	0.25*	45*	50*	R-2	Duplex	MF-1	Medium Density	R-2	Restricted Multiple Resid.	R-2	Multi-Family Residential	R-2	2 Family Residence	R-2	MF, 4,000 sq.ft./unit
				R-3	Multi-Family, Apartments	MF-2	Multi-Family	R-3	Limited Multiple Resid.	R-3R	Multi-Family Restricted	R-3	Multiple Family, Residential	R-3	MF, 3,000 sq.ft./unit
				R-4	Multi-Family, General	MF-3	High Density	R-4	General Multiple Resid.	R-3	Multi-Family Limited	R-4	Multiple Family, Residential	R-4	MF, 1,500 sq.ft./unit
				R-5	Townhouse Residential					R-4	Multi-Family General	R-5	Multiple Family, Residential	R-4A	MF, 1,000 sq.ft./unit
										R-Th	Townhouse			R-5	MF, 1,000 sq.ft./unit
				MH	Mobile Home	MH-1	Mobile Homes	TCR-2	TC, Restricted Multi-Res.	RMH	Mobile Home Residence	MHR	Manufactured Housing, Resid.	CP/BP	Business Park
				CTP	Commercial Trailer Park			TCR-3	TC, General Res.	MHS	Manufactured Housing Subd.			R-H	Resort District
										TP	Trailer Park				
Industrial	0.15*	55*	60*	I-1	Garden Type Industrial			M-1	Limited Industrial	I-1	Light Industrial			IND PARK	Industrial Park
				I-2	Light Industrial	I-1	Light Industrial			I-2	General Industrial	I-2	Light Industrial	A-1	Light Industrial
				I-3	General Industrial	I-2	General Industrial	M-2	General Industrial	I-3	Heavy Industrial	I-3	Heavy Industrial	A-2	Heavy Industrial
Commercial	0.1*	80*	75*	C-1	Light Commercial	C-1	Neighborhood Commercial	C-1	Neighborhood Comm.	CCR	Convenience Commercial	C-1	Neighborhood Commercial	C-1	Neighborhood Commercial
				C-2	General Commercial	C-2	Community Commercial	C-2	Limited Comm.	C-1	Neighborhood Commercial	C-2	Intermediate Commercial	C-2	Intermediate Commercial
				C-3	Central Commercial	C-3	Regional Commercial	C-3	General Comm.	C-2	General Commercial	C-3	General Commercial	C-3	General Commercial
				RS	Residential Services			OS	Office-Sercives	CCD	Central Comm. District	C-O	Commercial Office	C-O	Commercial Office
				RCC	Residential Conveniences			TCC	TC,High Intensity Mixed Use					HR	High Rise District
								TCB-1	TC, Limited Comm./General Manufacturing						
								TCB-2	TC, General Comm./ Light Manufacturing						
MISCELLANEOUS CATEGORIES: These zoning units should be evaluated on a case by case basis.															
				PAD	Planned Area Development	PAD	Planned Area Development			S	Private School	PD	Planned Development Overlay	PAD	Planned Area Development
				PSC-1	Planned Neighborhood Shopping										
				PSC-2	Planned Shopping Center							CS	Planned Shopping Center	PSC	Planned Shopping Center
				IB	Industrial Buffer										
						PCO	Planned C Offices	PEP	Planned Employment Park						
								PF	Public Facilities						
												SU	Special Uses		
												SC	Senior Citizen Overlay	PCD	Planned Community Development
												NUP	Neighborhood Plan of Development		
												RUP	Residential Plan of Development		
												IUP	Industrial Plan of Development		
														R.O.W.	Right of Way
														P-1	Parking, Open
														P-2	Parking, Structures
														D.G	Dwelling Group

NOTES

* These values have been selected to fit many typical settings in Maricopa County. However, the engineer/hydrologist should ALWAYS evaluate the specific circumstances in any particular watershed for hydrological variations from these typical values.

** RTIMP = Percent Effective Impervious Area, Including R.O.W.

** Percent Veg. Cover = Percent vegetation cover for pervious area only

January 1, 1995

Appendix D.2.2

Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
AF800	0.51	760	OPEN-5	0.25	0	0	Graded Land
AF800	0.19	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF800	0.00	740	WTR	0.00	0	0	Water
AF802	0.37	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF802	0.01	740	WTR	0.00	0	0	Water
AF803	1.94	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF803	0.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF803	0.74	760	OPEN-5	0.25	0	0	Graded Land
AF805	0.45	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF805	0.15	760	OPEN-5	0.25	0	0	Graded Land
AF807	0.00	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF807	0.40	750	AGR	0.50	0	85	Agriculture
AF807	0.52	760	OPEN-5	0.25	0	0	Graded Land
AF810	0.25	320	IND-3	0.15	55	60	Industrial
AF810	1.84	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF810	0.02	760	OPEN-5	0.25	0	0	Graded Land
AF820	0.69	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF830	0.23	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF850	0.01	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF850	0.01	160	VSLR	0.25	40	50	Very Small Lot Residential - Single Family (>6 du per acre-includes mobile home
AF850	0.00	190	VHDR	0.25	85	50	Very High Density Residential - Multi Family (> 15 du per acre)
AF850	0.03	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
AF850	0.01	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF852	0.07	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF852	0.04	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
AF854	0.16	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF854	0.11	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
AF860	0.08	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
AF860	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF862	0.06	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
AF862	0.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF864	0.05	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
AF866	0.23	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF866	0.20	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
IW300	0.20	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW300	1.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW300	0.04	740	WTR	0.00	0	0	Water
IW302	0.20	620	INS-5	0.15	55	60	Airports (Includes public use airports)
IW302	1.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW302	0.02	740	WTR	0.00	0	0	Water

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Entellus

SHEET _____ OF _____

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CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW310	0.33	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW310	0.00	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW310	0.82	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW310	0.02	740	WTR	0.00	0	0	Water
IW312	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW312	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW312	0.53	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW314	0.09	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW314	0.01	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW314	2.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW314	0.01	740	WTR	0.00	0	0	Water
IW318	0.13	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW318	0.43	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW322	1.87	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW326	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW330	1.03	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW334	0.10	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW334	1.13	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW334	0.02	740	WTR	0.00	0	0	Water
IW338	0.09	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW338	0.23	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW342	0.06	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW342	0.28	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW346	0.10	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW346	3.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW349	0.02	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW349	0.05	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
IW349	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW349	0.16	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW350	2.16	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW351	0.04	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
IW351	0.27	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW352	0.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW353	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW353	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW353	2.78	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW354	0.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW356	0.29	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW357	0.03	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW357	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW357	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW357	0.65	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW358	0.15	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW359	0.08	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW359	0.04	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW359	2.78	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW360	0.22	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
IW360	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW360	0.57	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW361	0.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW362	0.17	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW363	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW363	0.01	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
IW363	0.04	160	VSLR	0.25	40	50	Very Small Lot Residential - Single Family (>6 du per acre-includes mobile home
IW363	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW363	0.51	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW364	0.04	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW364	1.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW365	0.03	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW365	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW365	0.44	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW366	0.02	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW366	0.01	520	INS-1	0.25	45	80	Educational (Public schools, private schools and universities)
IW366	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW366	0.98	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW367	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW367	0.04	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW368	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW368	0.26	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW369	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW369	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW369	0.77	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW370	0.16	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW370	0.03	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW370	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW370	0.67	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW371	0.01	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW371	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW371	0.02	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW372	0.00	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) - Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW372	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW372	0.29	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW374	0.03	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW374	0.14	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW374	0.04	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW374	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW374	0.17	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW375	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW375	0.63	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW377	0.09	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW377	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW377	0.01	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW380	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW380	0.48	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW381	0.14	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW381	0.03	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW381	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW381	0.19	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW382	0.21	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW382	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW382	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW382	0.36	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW384	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
IW384	0.07	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW386	0.11	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW386	0.01	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW386	0.25	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW387	1.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW388	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW388	0.05	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
IW388	0.09	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW388	1.07	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW389	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW389	0.12	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW390	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW390	0.30	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW390A	0.81	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW390A	0.07	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
IW392	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
IW392	1.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)

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Entellus

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW394	1.71	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW394	2.45	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
IW395	0.97	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW395	6.87	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
IW396	0.58	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
IW397	4.79	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PD700	1.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD700	0.02	740	WTR	0.00	0	0	Water
PD704	0.17	760	OPEN-5	0.25	0	0	Graded Land
PD704	0.18	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD704	0.00	740	WTR	0.00	0	0	Water
PD708	0.01	760	OPEN-5	0.25	0	0	Graded Land
PD708	2.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD708	0.05	740	WTR	0.00	0	0	Water
PD712	0.17	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
PD712	0.71	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD712A	0.76	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD716	1.73	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD716	0.01	740	WTR	0.00	0	0	Water
PD720	0.57	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD720	0.02	740	WTR	0.00	0	0	Water
PD726	0.13	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD726	0.29	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD726A	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD726A	1.08	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD726A	0.01	740	WTR	0.00	0	0	Water
PD726B	0.56	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD726B	0.39	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD732	0.44	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD732	0.03	740	WTR	0.00	0	0	Water
PD736	0.76	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD736	0.01	740	WTR	0.00	0	0	Water
PD740	0.62	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD740	0.59	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD740	0.04	740	WTR	0.00	0	0	Water
PD744	0.10	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD744	0.69	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD744	0.00	740	WTR	0.00	0	0	Water
PD748	0.19	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD748	0.09	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)

Appendix D.2.2

Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PD752	0.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD752	0.09	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PD752	0.01	740	WTR	0.00	0	0	Water
PD756	0.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD756	3.11	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PD756	0.01	740	WTR	0.00	0	0	Water
PD760	0.14	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD760	0.71	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PD760	0.02	740	WTR	0.00	0	0	Water
PI600	0.58	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI600	0.01	740	WTR	0.00	0	0	Water
PI600A	0.47	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI600A	0.01	740	WTR	0.00	0	0	Water
PI603	0.05	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI603	0.01	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI603	0.46	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI604	0.28	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI604	0.02	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI604	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI606	0.16	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI606	0.38	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI606	0.52	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI606A	0.32	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI606A	0.12	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI606A	0.01	740	WTR	0.00	0	0	Water
PI609	0.65	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI609	0.28	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI609	0.96	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI609	0.02	740	WTR	0.00	0	0	Water
PI612	0.19	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI612	0.54	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI615	0.68	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI615	0.12	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI615	0.02	740	WTR	0.00	0	0	Water
PI618	0.00	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI618	0.26	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI618	0.02	740	WTR	0.00	0	0	Water
PI621	0.03	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI621	0.87	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI621	0.00	740	WTR	0.00	0	0	Water

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CLIENT: FCDMC

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PI624	0.11	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI624	0.09	210	COM-2	0.10	80	65	Specialty Commercial (<=50,000 sq. ft.)
PI624	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
PI624	0.53	620	INS-5	0.15	55	60	Airports (Includes public use airports)
PI624	0.45	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI624	0.01	740	WTR	0.00	0	0	Water
PI624A	0.22	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI624A	0.17	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI624A	1.51	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI624A	0.90	750	AGR	0.50	0	85	Agriculture
PI628	0.07	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI628	0.46	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI628	0.03	740	WTR	0.00	0	0	Water
PI633	0.31	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI633	0.02	740	WTR	0.00	0	0	Water
PI635	0.11	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
PI635	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
PI635	0.31	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI635	0.14	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PI635	0.02	740	WTR	0.00	0	0	Water
PI636	0.06	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
PI636	0.03	620	INS-5	0.15	55	60	Airports (Includes public use airports)
PI636	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI639	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
PI639	0.31	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI642	0.19	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI642	0.04	750	AGR	0.50	0	85	Agriculture
PI645	0.44	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI645	1.06	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI645	0.01	740	WTR	0.00	0	0	Water
PI645	0.06	750	AGR	0.50	0	85	Agriculture
PI645A	0.22	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
PI645A	0.05	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI645A	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI645A	1.31	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI648	0.14	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI648	1.59	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI651	0.42	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI654	0.17	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI654	3.84	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)

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CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PI657	0.04	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI657	0.82	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI660	0.06	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI660	0.78	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI663	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI663	0.59	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI669	0.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI669	0.00	740	WTR	0.00	0	0	Water
PI669	0.06	750	AGR	0.50	0	85	Agriculture
PI672	1.48	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI672	0.01	740	WTR	0.00	0	0	Water
PI672	0.01	750	AGR	0.50	0	85	Agriculture
PI675	0.06	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI678	0.09	300	IND-1	0.15	55	60	General Industrial (Industrial where no detail available)
PI678	0.01	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI678	0.69	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI681	0.04	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI681	0.07	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI681	0.86	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI684	0.01	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
PI684	0.72	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI687	1.03	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI687	5.96	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PI688	0.02	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI688	3.17	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PI689	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI689	6.76	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PI690	0.61	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI693	0.81	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI693	0.01	740	WTR	0.00	0	0	Water
SV200	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
SV200	2.28	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV202	0.37	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV202	1.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV202	0.03	740	WTR	0.00	0	0	Water
SV203	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
SV203	0.06	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV205	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV205	0.17	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV208	0.33	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
SV208	0.72	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV210	0.70	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV212	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV212	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
SV212	3.71	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV212	0.35	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV214	1.84	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV214	0.01	740	WTR	0.00	0	0	Water
SV216	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
SV216	1.56	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV218	1.20	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV218	0.02	740	WTR	0.00	0	0	Water
SV219	0.83	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV219	0.05	740	WTR	0.00	0	0	Water
SV220	0.54	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV220	0.05	740	WTR	0.00	0	0	Water
SV230	0.69	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV230	0.17	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV232	0.97	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV232	2.03	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV236	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
SV236	0.33	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV236	0.24	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV240	0.14	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV240	3.50	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV242	0.04	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV242	0.05	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV244	0.27	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV244	0.68	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV246	0.13	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV246	0.01	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV248	0.13	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV248	1.12	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV250	0.12	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV251	0.25	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV252	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
SV252	0.14	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV254	0.08	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV256	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV258	0.17	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
SV258	0.55	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV260	1.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV260	0.03	740	WTR	0.00	0	0	Water
SV264	0.00	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV264	1.89	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV264A	0.07	620	INS-5	0.15	55	60	Airports (Includes public use airports)
SV264A	2.78	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV264A	0.01	740	WTR	0.00	0	0	Water
SV268	0.11	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV268	1.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV268	0.04	740	WTR	0.00	0	0	Water
SV272	0.04	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
SV272	0.08	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV272	1.07	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV276	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV276	0.04	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV276	0.87	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV280	0.15	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV280	0.13	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV280	0.77	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV284	0.08	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV284	0.19	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV286	1.52	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV290	0.02	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV290	0.79	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV294	0.07	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV294	2.57	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
SV298	0.17	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV298	0.87	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW400	0.06	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW400	0.34	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW400	0.15	310	IND-2	0.15	80	75	Warehouse/Distribution Centers
TW400	0.52	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW400	3.17	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW402	0.33	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW402	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW402	4.54	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW404	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW404	2.03	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW406	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)

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BY _____ DATE _____

CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
TW406	0.15	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW408	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW408	0.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW408	0.65	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW410	0.00	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW410	0.29	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW412	0.13	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW412	0.05	620	INS-5	0.15	55	60	Airports (Includes public use airports)
TW412	1.88	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW414	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW414	0.33	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW414	0.81	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW416	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW416	0.53	620	INS-5	0.15	55	60	Airports (Includes public use airports)
TW416	0.01	740	WTR	0.00	0	0	Water
TW418	0.02	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
TW418	0.04	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW418	0.73	620	INS-5	0.15	55	60	Airports (Includes public use airports)
TW418	0.50	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW418	0.07	740	WTR	0.00	0	0	Water
TW420	0.00	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW420	0.04	620	INS-5	0.15	55	60	Airports (Includes public use airports)
TW420	0.76	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW422	0.20	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW422	0.49	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW424	0.86	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
TW424	0.55	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW424	0.03	740	WTR	0.00	0	0	Water
TW429	0.30	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW429	0.25	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW429	0.00	740	WTR	0.00	0	0	Water
TW430	0.21	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW430	0.24	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW430	1.98	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW430	0.05	740	WTR	0.00	0	0	Water
TW431	0.11	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW431	0.09	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW431	0.62	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW431	0.04	750	AGR	0.50	0	85	Agriculture
TW432	0.25	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)

Appendix D.2.2

Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
TW432	0.59	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW432	0.02	750	AGR	0.50	0	85	Agriculture
TW434	0.04	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW434	0.04	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW434	0.39	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW434	0.03	750	AGR	0.50	0	85	Agriculture
TW436	0.07	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW436	0.17	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW436	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW436	0.40	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW440	0.05	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW440	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW442	0.13	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW442	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW442	0.20	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW444	0.03	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW444	0.13	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW444	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW444	0.13	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW446	0.02	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW446	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW446	0.28	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW446A	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW446A	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW448	0.33	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW450	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW450	1.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW450A	0.03	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW450A	0.84	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW450B	0.06	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW450B	0.35	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW452	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW452	0.44	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW452A	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW452A	1.04	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW452B	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW452B	1.01	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW454	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW454	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW456	0.16	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)

Appendix D.2.2

Entellus

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
TW458	0.08	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW458	0.59	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW459	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW459	1.03	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW460	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW460	2.31	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW462	0.01	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
TW462	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW478	0.00	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW478	0.04	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW478	0.20	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW478	0.01	740	WTR	0.00	0	0	Water
TW480	0.06	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW480	0.16	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW480	0.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW480	0.04	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW480	0.44	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW482	0.02	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW482	0.06	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
TW482	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW482	0.63	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW484	0.08	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
TW484	0.05	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
TW484	0.20	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
TW485	0.02	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW485	0.08	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
TW485	2.27	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI500	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI500	0.97	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI502	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI502	0.06	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI502	0.02	310	IND-2	0.15	80	75	Warehouse/Distribution Centers
WI502	1.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI504	0.09	310	IND-2	0.15	80	75	Warehouse/Distribution Centers
WI504	1.24	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI506	0.50	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
WI506	0.05	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI506	1.01	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI508	0.02	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI508	0.11	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)

Appendix D.2.2

Entellus

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BY _____ DATE _____

CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI508	0.07	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
WI508	0.51	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI510	0.22	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI510	0.04	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI510	0.00	620	INS-5	0.15	55	60	Airports (Includes public use airports)
WI510	0.97	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI510A	0.15	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI510A	0.03	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
WI510A	0.92	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI510A	0.02	740	WTR	0.00	0	0	Water
WI512	0.22	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI512	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI512	0.21	620	INS-5	0.15	55	60	Airports (Includes public use airports)
WI512	0.90	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI514	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI514	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI514	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI514	0.02	740	WTR	0.00	0	0	Water
WI516	0.10	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI516	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI516	0.03	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI518	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI518	0.02	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI518	0.48	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI524	0.07	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI524	0.76	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI524	0.10	750	AGR	0.50	0	85	Agriculture
WI525	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI525	0.25	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI525	0.09	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI525	1.47	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI525	0.04	740	WTR	0.00	0	0	Water
WI525	0.08	750	AGR	0.50	0	85	Agriculture
WI526	0.03	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI527	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI527	0.65	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI527	0.02	740	WTR	0.00	0	0	Water
WI528	0.04	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI528	0.29	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI528	0.02	740	WTR	0.00	0	0	Water

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Entellus

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CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI529	0.04	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI529	0.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI529	0.02	740	WTR	0.00	0	0	Water
WI530	2.34	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI530	0.01	740	WTR	0.00	0	0	Water
WI532	0.30	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI534	0.07	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI534	0.37	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI536	0.14	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI536	0.01	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI536	1.19	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI538	0.10	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI538	1.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI538A	0.08	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI538A	0.69	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI540	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI540	1.22	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI542	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI542	1.14	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI542	0.00	740	WTR	0.00	0	0	Water
WI544	0.80	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI544	1.00	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI546	0.36	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI546	0.25	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI548	0.30	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI550	0.03	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI550	0.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI550	0.01	740	WTR	0.00	0	0	Water
WI552	0.04	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI552	0.38	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI554	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI554	0.05	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI554	0.90	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI556	0.01	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI556	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI560	0.25	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI560	0.86	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI560	0.04	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI560	2.45	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI560A	0.03	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)

Appendix D.2.2

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CLIENT:	FCDMC	CHECK		DATE	
JOB:	Wittmann Area Drainage Master Study Update	JOB NO.	310.032		

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI560A	2.02	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI562	0.11	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI562	0.75	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI564	0.01	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI564	1.79	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI566	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI566	0.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI570	0.00	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)

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BY _____ DATE _____

CLIENT: FCDMC

CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI570	2.20	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI570	0.02	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI572	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI572	1.56	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI572	0.46	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI574	0.19	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI576	0.29	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI576	0.89	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI576A	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI576A	1.18	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI576B	0.04	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI576B	0.41	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI578	0.02	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI578	0.44	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI580	0.06	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI580	1.25	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI580A	0.04	600	FWY-1	0.30	20	30	General Transportation (Transportation where no detail available)
WI580A	2.70	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI580A	0.03	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI580B	0.61	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI580B	0.00	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI582	0.01	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI582	0.32	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI584	0.14	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI584	0.22	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI584	0.06	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WI584	0.82	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WI584	0.00	740	WTR	0.00	0	0	Water
WT100	0.05	610	FWY-2	0.10	80	30	Transportation (Includes railroads, railyards, transit centers and freeways)
WT100	2.37	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WT100	1.41	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT110	1.80	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WT110	1.08	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT120	1.59	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WT120	1.19	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT130	0.48	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
WT130	2.08	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT140	3.77	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT150	1.07	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT150A	4.73	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Existing Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WT160	0.80	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
AF800	0.09	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
AF800	0.52	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
AF800	0.04	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF800	0.02	230	COM-4	0.10	80	75	Community Commercial (100,000 to 500,000 sq. ft.)
AF800	0.04	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
AF800	0.00	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
AF802	0.16	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
AF802	0.03	230	COM-4	0.10	80	75	Community Commercial (100,000 to 500,000 sq. ft.)
AF802	0.01	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
AF802	0.02	740	WTR	0.00	0	0	Water
AF802	0.16	810	INS-6	0.10	80	75	Business Park (Includes enclosed industrial, office or retail in a planned envir
AF803	0.07	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
AF803	0.79	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
AF803	1.30	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
AF803	0.08	580	IND-5	0.15	80	75	Other Employment - medium
AF803	0.52	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF803	0.00	740	WTR	0.00	0	0	Water
AF805	0.35	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
AF805	0.08	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
AF805	0.14	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF805	0.03	740	WTR	0.00	0	0	Water
AF807	0.92	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
AF810	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
AF810	0.15	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
AF810	0.63	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
AF810	0.35	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF810	0.07	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF810	0.01	740	WTR	0.00	0	0	Water
AF810	0.90	810	INS-6	0.10	80	75	Business Park (Includes enclosed industrial, office or retail in a planned envir
AF820	0.31	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
AF820	0.38	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF830	0.13	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
AF830	0.10	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF850	0.04	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
AF850	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
AF850	0.16	190	VHDR	0.25	85	50	Very High Density Residential - Multi Family (> 15 du per acre)
AF850	0.02	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF852	0.11	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
AF854	0.26	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
AF854	0.01	580	IND-5	0.15	80	75	Other Employment - medium
AF860	0.01	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF860	0.07	220	COM-3	0.10	80	65	Neighborhood Commercial (50,000 to 100,000 sq. ft.)
AF860	0.05	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF860	0.21	810	INS-6	0.10	80	75	Business Park (Includes enclosed industrial, office or retail in a planned envir
AF862	0.06	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF862	0.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
AF864	0.05	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
AF866	0.32	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
AF866	0.04	220	COM-3	0.10	80	65	Neighborhood Commercial (50,000 to 100,000 sq. ft.)
AF866	0.07	580	IND-5	0.15	80	75	Other Employment - medium
IW300	0.35	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW300	0.99	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
IW300	0.01	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
IW300	0.11	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
IW302	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW302	0.47	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
IW302	0.00	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
IW302	0.82	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
IW310	0.46	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW310	0.01	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
IW310	0.64	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
IW310	0.06	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
IW312	0.08	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW312	0.46	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW312	0.02	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
IW314	0.67	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW314	0.22	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
IW314	1.27	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW318	0.57	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW322	1.49	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW322	0.37	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
IW326	0.32	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW330	1.03	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW334	0.22	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW334	0.19	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
IW334	0.83	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
IW338	0.32	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW342	0.34	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW346	3.45	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW349	0.24	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW350	0.04	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW350	1.20	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW350	0.93	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
IW351	0.31	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW352	0.10	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW353	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW353	2.49	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW353	0.30	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
IW354	0.35	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW356	0.29	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW357	0.74	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW358	0.15	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW359	1.98	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW359	0.59	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW359	0.34	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
IW360	0.80	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW361	0.35	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW362	0.17	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW363	0.62	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW364	1.14	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW365	0.03	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW365	0.44	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

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Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW366	0.91	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW366	0.13	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW367	0.04	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW368	0.26	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW369	0.04	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW369	0.74	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW370	0.06	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW370	0.80	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW371	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW371	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW372	0.31	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW374	0.07	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW374	0.31	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW374	0.00	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW375	0.64	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW377	0.03	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW377	0.07	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW380	0.43	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW380	0.05	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW381	0.11	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW381	0.27	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW382	0.02	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW382	0.59	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW384	0.08	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW386	0.26	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW386	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW386	0.10	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW387	0.21	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW387	1.14	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW388	0.22	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW388	0.97	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
IW388	0.03	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
IW389	0.13	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW390	0.29	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

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Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
IW390	0.02	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW390A	0.46	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW390A	0.43	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW392	1.10	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW394	1.42	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW394	2.74	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW395	0.87	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW395	6.97	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW396	0.05	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
IW396	0.53	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
IW397	4.81	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD700	1.28	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD700	0.09	740	WTR	0.00	0	0	Water
PD704	0.06	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD704	0.20	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD704	0.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PD704	0.04	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
PD704	0.02	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD708	1.39	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD708	0.82	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD708	0.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PD708	0.02	190	VHDR	0.25	85	50	Very High Density Residential - Multi Family (> 15 du per acre)
PD708	0.04	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
PD708	0.08	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD708	0.02	740	WTR	0.00	0	0	Water
PD712	0.66	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD712	0.00	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD712	0.22	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD712A	0.59	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD712A	0.10	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD712A	0.08	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD716	1.53	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD716	0.00	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD716	0.21	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)

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CLIENT: FCDMC CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PD720	0.18	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD720	0.34	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PD720	0.06	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PD720	0.00	740	WTR	0.00	0	0	Water
PD726	0.42	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD726A	0.89	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD726A	0.19	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD726A	0.01	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD726A	0.00	740	WTR	0.00	0	0	Water
PD726B	0.91	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD726B	0.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PD732	0.34	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD732	0.04	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD732	0.08	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD732	0.01	740	WTR	0.00	0	0	Water
PD736	0.77	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD740	1.25	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD744	0.77	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD744	0.02	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PD748	0.26	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD748	0.00	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PD748	0.02	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
PD752	0.14	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD752	0.05	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD756	1.47	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD756	0.54	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD756	0.07	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PD756	0.08	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
PD756	0.03	230	COM-4	0.10	80	75	Community Commercial (100,000 to 500,000 sq. ft.)
PD756	0.00	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
PD756	1.02	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PD760	0.34	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PD760	0.35	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PD760	0.16	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PD760	0.01	740	WTR	0.00	0	0	Water
PI600	0.45	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI600	0.15	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI600A	0.47	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI603	0.13	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI603	0.19	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI603	0.19	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI604	0.10	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI604	0.25	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI606	0.10	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI606	0.33	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI606	0.63	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI606A	0.45	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI609	0.96	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI609	0.30	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI609	0.65	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI612	0.36	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI612	0.17	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI612	0.20	580	IND-5	0.15	80	75	Other Employment - medium
PI615	0.78	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI615	0.04	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI618	0.28	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI621	0.83	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI621	0.04	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI621	0.03	580	IND-5	0.15	80	75	Other Employment - medium
PI624	0.20	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI624	0.73	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI624	0.27	580	IND-5	0.15	80	75	Other Employment - medium
PI624A	0.38	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI624A	0.02	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
PI624A	2.34	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI624A	0.05	580	IND-5	0.15	80	75	Other Employment - medium
PI628	0.55	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI633	0.07	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PI633	0.17	580	IND-5	0.15	80	75	Other Employment - medium
PI633	0.09	700	OPEN-1	0.35	5	30	General Open Space (Open space where no detail available)
PI635	0.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI635	0.58	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PI636	0.40	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI636	0.00	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
PI636	0.01	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
PI639	0.32	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI639	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
PI642	0.23	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI645	1.39	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI645	0.13	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI645	0.04	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI645A	0.83	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI645A	0.07	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI645A	0.69	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI645A	0.01	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI648	0.30	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI648	1.37	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI648	0.06	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
PI651	0.17	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI651	0.25	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI654	0.07	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI654	1.74	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI654	1.12	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI654	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI654	1.04	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI657	0.16	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI657	0.57	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI657	0.13	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI660	0.15	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI660	0.21	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI660	0.41	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
PI660	0.06	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
PI663	0.16	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI663	0.43	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI669	0.28	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI672	1.50	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI672	0.01	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI675	0.06	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI678	0.17	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI678	0.63	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI681	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI681	0.40	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI681	0.38	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI681	0.19	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI684	0.03	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI684	0.69	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI687	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
PI687	6.97	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI688	3.19	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI689	6.77	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
PI690	0.46	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
PI690	0.15	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
PI693	0.83	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV200	0.65	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV200	1.10	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV200	0.21	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
SV200	0.14	190	VHDR	0.25	85	50	Very High Density Residential - Multi Family (> 15 du per acre)
SV200	0.15	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
SV200	0.03	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
SV200	0.00	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV202	0.61	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV202	0.79	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV202	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV202	0.03	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
SV203	0.06	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV205	0.05	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

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Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
SV205	0.17	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV205	0.27	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV208	0.19	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV208	0.72	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV208	0.13	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV210	0.24	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV210	0.31	510	COM-7	0.10	80	75	Tourist and Visitor Accommodations (Hotels, motels and resorts)
SV210	0.15	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV212	0.43	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV212	3.28	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV212	0.02	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV212	0.37	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV214	0.49	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV214	1.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV214	0.32	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
SV216	0.67	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV216	0.78	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV216	0.12	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
SV218	1.22	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV219	0.30	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV219	0.59	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV220	0.59	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV230	0.37	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV230	0.08	510	COM-7	0.10	80	75	Tourist and Visitor Accommodations (Hotels, motels and resorts)
SV230	0.16	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV230	0.25	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV232	0.57	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV232	2.04	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV232	0.38	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
SV236	0.26	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV236	0.05	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV236	0.01	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
SV236	0.26	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV240	0.12	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)

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Future Land Use Summary by Basin

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SV240	3.52	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV242	0.04	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV242	0.05	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV244	0.23	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV244	0.00	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
SV244	0.71	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV246	0.12	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV246	0.01	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV248	0.13	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV248	0.19	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV248	0.93	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV250	0.12	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV251	0.25	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV252	0.09	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV252	0.05	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV254	0.08	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV256	0.05	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV258	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV258	0.54	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV258	0.18	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
SV260	0.14	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV260	0.92	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV260	0.18	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV264	1.30	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV264	0.03	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV264	0.56	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV264A	0.40	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV264A	2.47	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV268	0.04	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV268	0.33	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV268	1.00	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
SV272	1.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV272	0.05	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV272	0.14	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
SV276	0.65	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV276	0.27	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV280	0.64	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV280	0.42	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
SV284	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV284	0.26	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV286	1.52	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV290	0.20	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV290	0.61	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV294	0.48	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV294	2.16	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
SV298	0.71	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
SV298	0.33	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
TW400	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW400	0.17	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
TW400	0.28	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW400	0.05	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
TW400	2.28	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW400	1.23	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW400	0.22	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW402	0.20	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW402	1.58	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW402	1.13	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW402	1.51	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW402	0.46	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW404	0.07	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW404	1.56	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW404	0.42	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW406	0.15	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW408	0.09	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW408	0.00	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW408	0.65	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW408	0.14	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW410	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
TW410	0.20	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW410	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
TW410	0.00	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
TW410	0.08	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW412	0.06	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW412	0.63	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
TW412	1.04	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW412	0.33	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW414	0.19	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW414	0.81	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW414	0.16	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
TW416	0.54	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW416	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW418	0.42	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW418	0.90	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW418	0.04	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW420	0.15	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW420	0.51	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW420	0.14	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW422	0.27	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW422	0.02	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
TW422	0.39	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW424	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW424	1.42	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW429	0.21	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW429	0.33	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW430	1.69	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW430	0.79	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW431	0.86	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW432	0.86	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW434	0.50	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW436	0.65	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW440	0.10	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW442	0.35	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)

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JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
TW444	0.31	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW446	0.32	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW446A	0.33	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW448	0.33	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW450	1.23	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW450A	0.26	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW450A	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW450A	0.60	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW450B	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW450B	0.39	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW452	0.42	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW452	0.03	580	IND-5	0.15	80	75	Other Employment - medium
TW452A	0.01	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW452A	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW452A	1.04	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW452B	1.03	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW454	0.33	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW456	0.16	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW458	0.03	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW458	0.33	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW458	0.31	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW459	0.76	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW459	0.27	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW460	0.87	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW460	1.45	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
TW462	0.05	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
TW462	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW478	0.24	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW478	0.01	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
TW480	0.73	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW482	0.11	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW482	0.11	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
TW482	0.01	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
TW482	0.52	580	IND-5	0.15	80	75	Other Employment - medium

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JOB: Wittmann Area Drainage Master Study Update

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Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
TW484	0.16	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW484	0.16	580	IND-5	0.15	80	75	Other Employment - medium
TW485	2.12	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
TW485	0.25	580	IND-5	0.15	80	75	Other Employment - medium
WI500	0.07	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI500	0.28	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI500	0.15	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI500	0.12	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
WI500	0.38	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI502	0.26	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI502	0.21	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI502	0.26	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
WI502	0.19	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI502	0.27	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI504	0.00	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI504	0.44	180	HDR	0.25	65	50	High Density Residential - Multi Family (10-15 du per acre)
WI504	0.09	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI504	0.79	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI506	0.63	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI506	0.31	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI506	0.54	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI506	0.03	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI506	0.04	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WI508	0.56	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI508	0.07	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
WI508	0.07	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI508	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI510	0.36	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI510	0.43	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
WI510	0.24	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI510	0.20	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI510A	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI510A	1.10	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI510A	0.00	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)

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Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI512	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI512	0.06	130	LDR-2	0.30	15	50	Large Lot Residential - Single Family (1 du per acre to 2 du per acre)
WI512	0.23	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI512	0.46	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI512	0.07	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI512	0.50	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI514	0.35	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI514	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI516	0.02	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI516	0.12	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI518	0.28	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI518	0.24	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI524	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI524	0.92	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI525	0.48	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI525	0.15	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI525	0.98	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI525	0.01	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI525	0.31	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI526	0.03	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI527	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI527	0.34	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI527	0.36	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI528	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI528	0.01	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI528	0.08	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI528	0.15	190	VHDR	0.25	85	50	Very High Density Residential - Multi Family (> 15 du per acre)
WI528	0.11	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI529	0.02	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI529	0.13	190	VHDR	0.25	85	50	Very High Density Residential - Multi Family (> 15 du per acre)
WI529	0.00	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI530	1.99	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI530	0.12	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI530	0.24	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)

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JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI532	0.30	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI534	0.43	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI536	0.00	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI536	0.22	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI536	1.11	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI536	0.01	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI538	0.71	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI538	0.72	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI538A	0.00	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI538A	0.27	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI538A	0.49	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI540	1.23	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI542	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI542	0.71	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI542	0.27	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI542	0.03	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI542	0.14	580	IND-5	0.15	80	75	Other Employment - medium
WI544	0.56	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI544	0.00	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI544	1.22	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI544	0.01	580	IND-5	0.15	80	75	Other Employment - medium
WI546	0.12	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI546	0.49	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI548	0.30	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI550	0.03	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI550	0.11	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI552	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI552	0.40	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI552	0.01	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI552	0.00	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WI554	0.01	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI554	0.34	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WI554	0.27	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI554	0.07	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)

Appendix D.2.2

Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC

CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI554	0.29	580	IND-5	0.15	80	75	Other Employment - medium
WI556	0.06	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI560	0.10	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI560	1.69	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI560	1.82	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI560	0.00	580	IND-5	0.15	80	75	Other Employment - medium
WI560A	1.72	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI560A	0.32	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI560A	0.01	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI562	0.22	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI562	0.51	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI562	0.13	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI564	0.69	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI564	1.11	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI566	0.10	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI570	1.46	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI570	0.76	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI572	1.66	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI572	0.02	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI572	0.36	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI574	0.19	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI576	1.18	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI576A	0.71	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI576A	0.49	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI576B	0.45	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI578	0.45	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI578	0.00	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI578	0.00	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI580	1.29	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI580	0.02	200	COM-1	0.10	80	60	General Commercial (Commercial where no detail available)
WI580A	2.69	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI580A	0.08	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WI580B	0.61	110	VLDR	0.30	5	30	Rural Residential (<= 1/5 du per acre)
WI582	0.02	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)

Appendix D.2.2

Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC

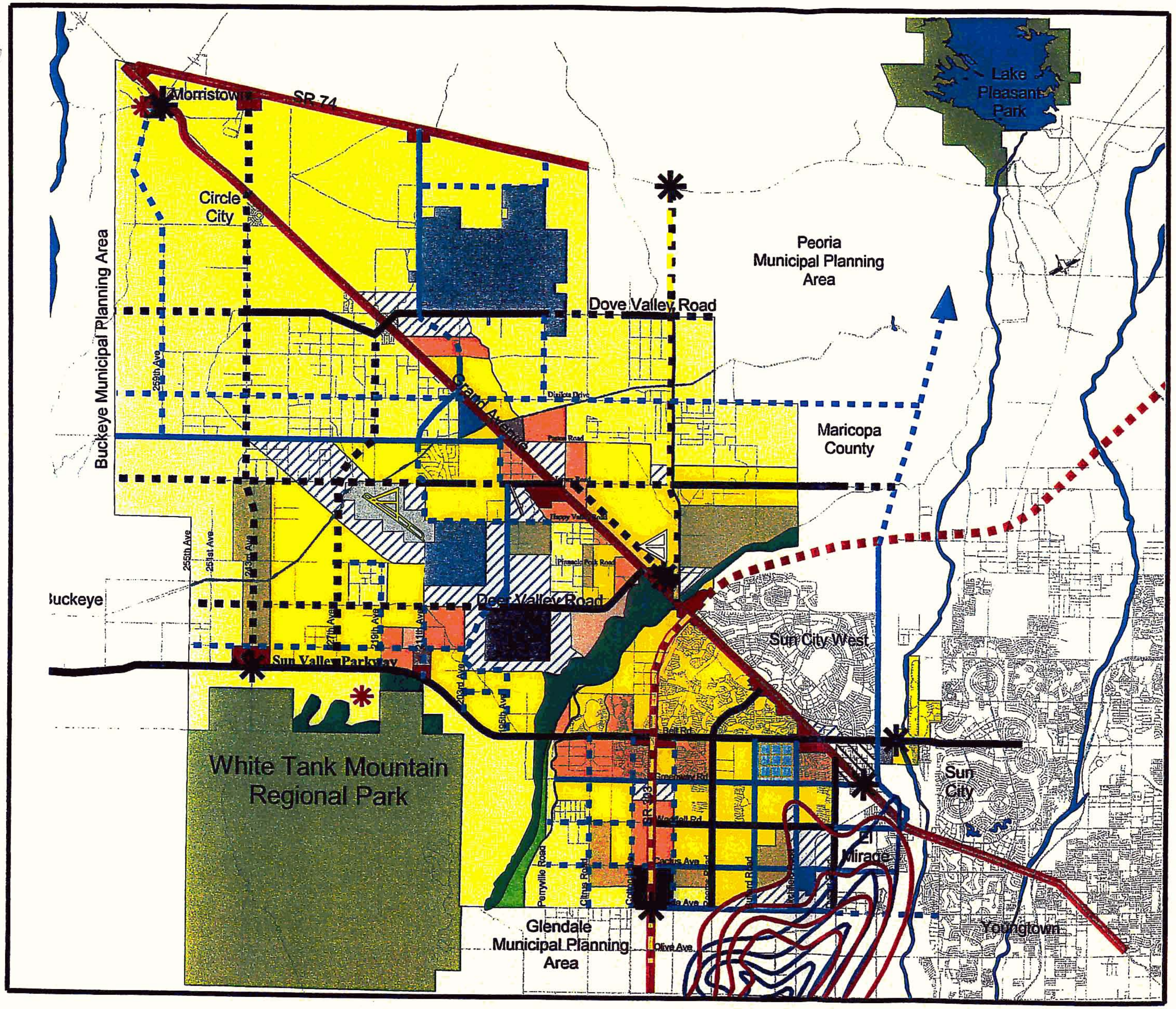
CHECK _____ DATE _____

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Future Land Use Summary by Basin

Basin ID	Area (sqmiles)	WMS Land Use Code	Mag Land Use Code	IA (in) Initial Abstractions	RTIMP	% Vegetation	Land Use Definition
WI582	0.12	170	MDR-2	0.25	45	50	Medium Density Residential - Muli Family (5-10 du per acre)
WI582	0.05	570	IND-4	0.15	80	25	Other Employment - low (Proving grounds and land fills)
WI582	0.13	580	IND-5	0.15	80	75	Other Employment - medium
WI584	0.99	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WI584	0.25	550	INS-4	0.10	80	75	Public Facilities (Includes community centers, power sub-stations, libraries, etc.)
WT100	1.79	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WT100	0.64	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
WT100	0.00	150	SLR	0.25	35	50	Small Lot Residential - Single Family (4-6 du per acre)
WT100	1.37	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT100	0.04	730	OPEN-4	0.35	0	30	Passive Open Space (Includes mountain preserves and washes)
WT110	1.57	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WT110	0.23	140	MDR-1	0.25	30	50	Medium Lot Residential - Single Family (2-4 du per acre)
WT110	1.08	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT120	1.59	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WT120	1.19	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT130	0.48	120	LDR-1	0.30	10	30	Estate Residential (1/5 du per acre to 1 du per acre)
WT130	2.08	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT140	3.77	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT150	1.07	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT150A	4.74	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)
WT160	0.80	710	OPEN-2	0.20	5	50	Active Open Space (Includes parks)



Land Use Plan

Figure 4-1

Land Use Classification

- Rural Residential (0-1 DU/AC) (1)
- Suburban Residential (1-3 DU/AC)
- Low Density Residential (3-5 DU/AC)
- Medium Density Residential (5-8 DU/AC)
- Medium/High Density Residential (8-15 DU/AC)
- High Density Residential (15-21 DU/AC)
- Surprise Center
- Original Townsite (2)
- Commercial (Greater than 25 acres) (3)
- Employment
- Mixed Use
- Agriculture
- Landfill
- Military
- Open Space
- Public Facilities
- Proving Grounds
- Resort Development
- Gateway

(1) Reference Rural Development Standards and Design Guidelines Policy

(2) See Original Townsite Revilzization Specific Plan

(3) Commercial under 25 acres can be approved in other land use classifications per criteria in the General Plan.

Street Classification

- Principal Arterial
- Major Arterial
- Minor Arterial
- Proposed Principal Arterial
- Proposed Major Arterial
- Proposed Minor Arterial
- Special Corridor
- 1988 MAG Noise Contours
- 1995 Luke A.F.B Noise Contours (1997 Revised)

Surprise General Plan 2020: Imagine the Possibilities Surprise, AZ

1 0 1 2 Miles

Partners for Strategic Action, Inc.
Neill/Vecchia and Associates
David Evans and Associates, Inc.

Revised by City of Surprise
December, 2001

City of Peoria General Plan

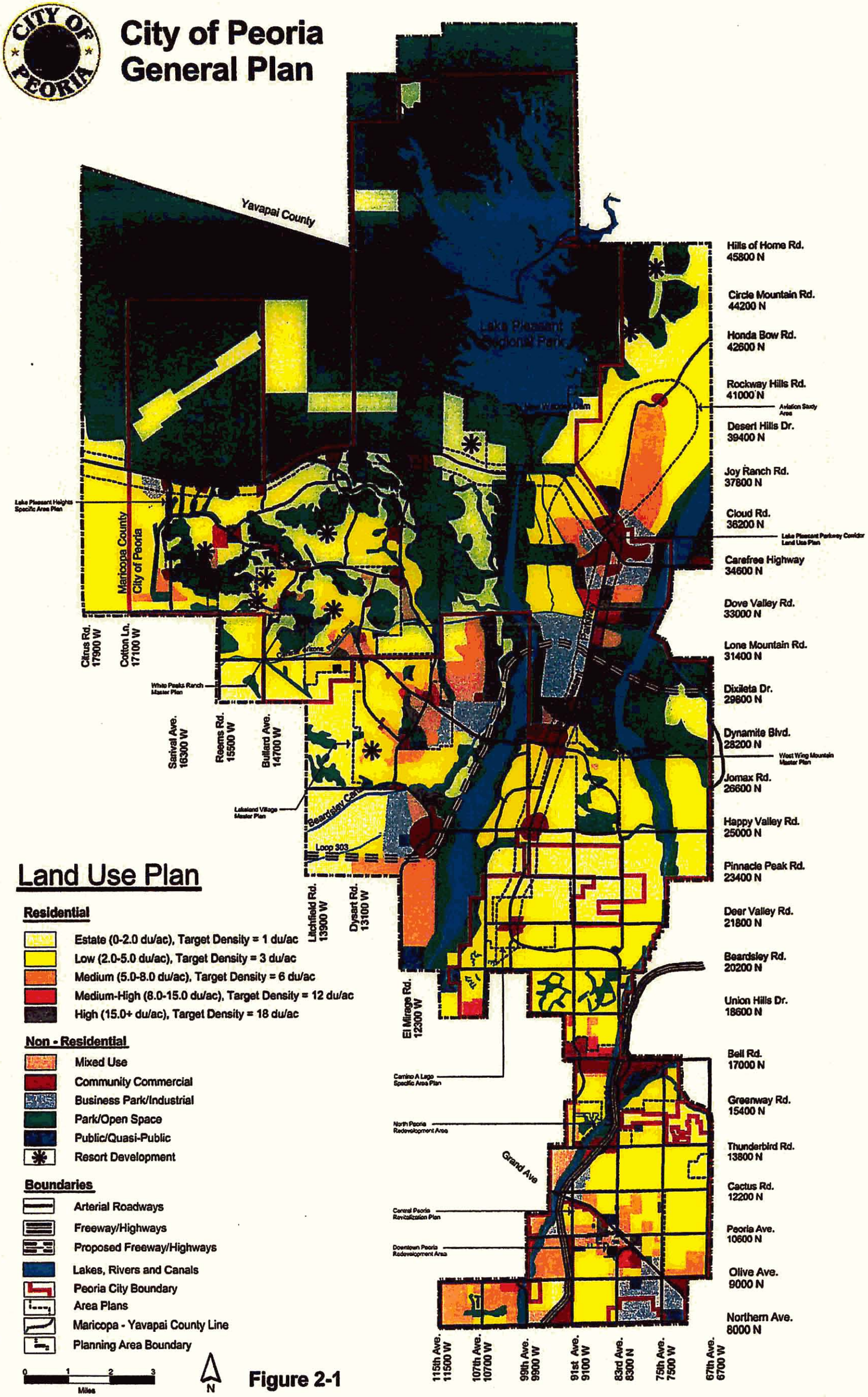


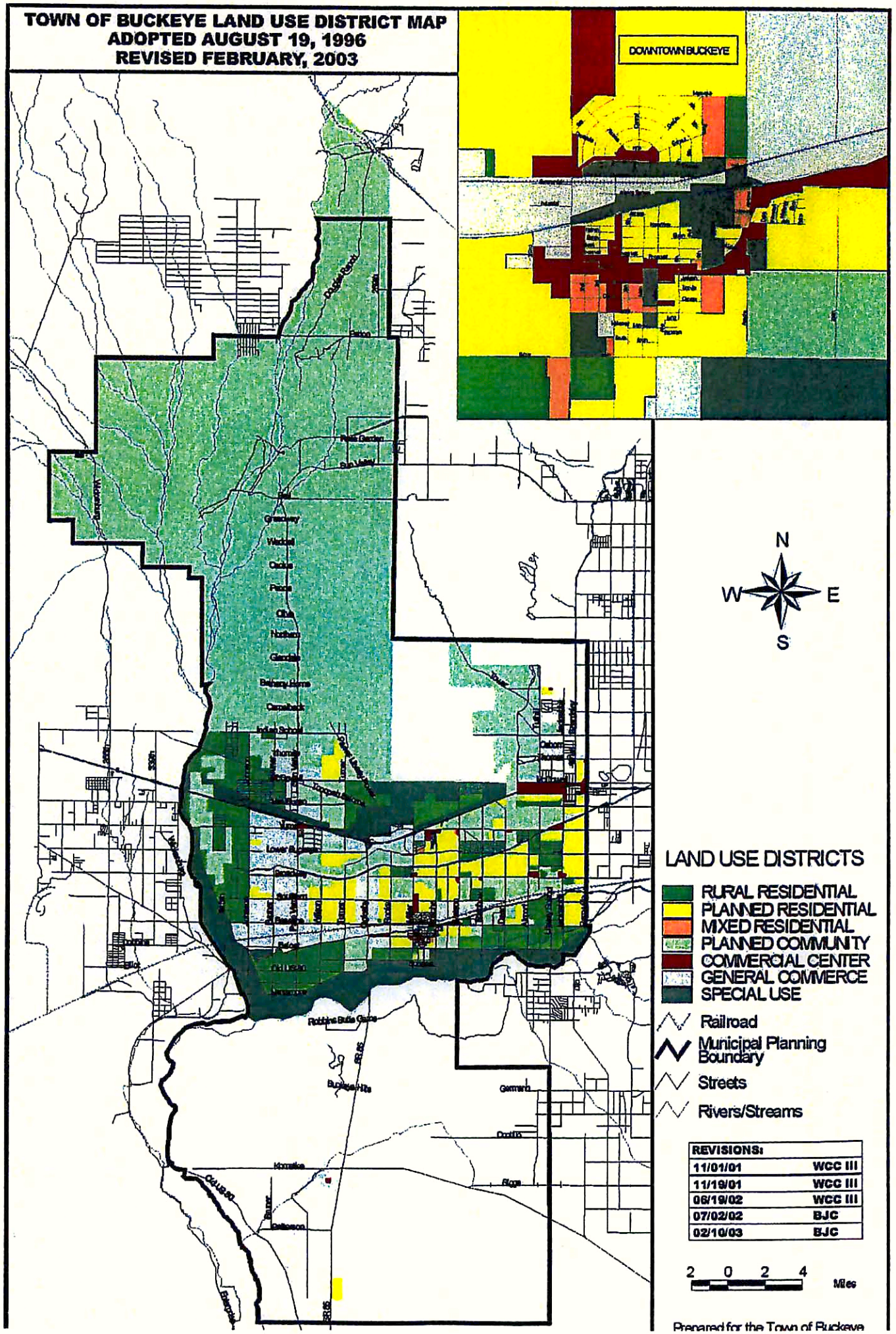
Figure 2-1

Source: BRW, Inc, Jan 2001.

Land Use Plan

ap 1/8/01 c:/peoria/projects/preferred_revised.apr

TOWN OF BUCKEYE LAND USE DISTRICT MAP
ADOPTED AUGUST 19, 1996
REVISED FEBRUARY, 2003



REVISIONS:	
11/01/01	WCC III
11/19/01	WCC III
06/19/02	WCC III
07/02/02	BJC
02/10/03	BJC

D.2.3. Time of Concentration

Table HY-D.2.3 Time of Concentration

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
AF800	10443	1.978	1434	1342	46.5	0.7163		46.5		46.5	B	0.654	0.482	0.654	0.482	Natural	Urban
AF802	6070	1.150	1346	1311	30.4	0.3902		30.4		30.4	B	0.613	0.411	0.563	0.374	Natural	Urban
AF803	22740	4.307	1340	1270	16.3	2.8368		16.3		16.3	A	1.129	0.752	1.117	0.742	Urban	Urban
AF805	7505	1.421	1320	1290	21.1	0.6276		21.1		21.1	B	0.817	0.510	0.754	0.467	Natural	Natural
AF807	8909	1.687	1300	1250	29.6	1.0224		29.6		29.6	A	0.463	0.236	0.467	0.238	Natural	Urban
AF810	15994	3.029	1344	1250	31.0	2.1166		31.0		31.0	B	1.125	0.667	1.121	0.665	Natural	Natural
AF820	12472	2.362	1285	1180	44.5	0.6957		44.5		44.5	B	0.904	0.809	0.838	0.743	Natural	Urban
AF830	7549	1.430	1220	1170	35.0	0.2663		35.0		35.0	B	0.663	0.663	0.608	0.603	Natural	Urban
AF850	4057	0.768	1176	1152	31.2	0.2178		31.2		31.2	A	0.296	0.185	0.271	0.168	Urban	Urban
AF852	3605	0.683	1178	1152	38.1	0.1678		38.1		38.1	A	0.263	0.171	0.238	0.153	Urban	Urban
AF854	5135	0.973	1194	1164	30.8	0.3382		30.8		30.8	A	0.346	0.207	0.313	0.185	Urban	Urban
AF860	9763	1.849	1198	1148	27.0	0.3627		27.0		27.0	A	0.563	0.569	0.525	0.527	Urban	Urban
AF862	2390	0.453	1160	1143	37.6	0.1772		37.6		37.6	A	0.221	0.098	0.200	0.088	Urban	Urban
AF864	5480	1.038	1146	1130	15.4	0.0868		15.4		15.4	A	0.508	0.724	0.467	0.659	Urban	Urban
AF866	7821	1.481	1150	1116	23.0	0.4549		23.0		23.0	A	0.483	0.354	0.446	0.324	Urban	Urban
IW300	18303	3.467	1536	1446	26.0	1.4800		26.0		26.0	B	1.438	1.251	1.288	1.059	Natural	Natural
IW302	19377	3.670	1546	1448	26.7	1.3264		26.7		26.7	B	1.467	1.431	1.367	1.261	Natural	Natural
[a] IW310	19517	3.696	1654	1548	28.7	1.1672	3.400	31.2		31.2	B	1.188	1.167	1.117	1.090	Natural	Natural
IW312	14836	2.810	2130	1910	78.3	0.5682		78.3		78.3	C	1.104	1.303	1.004	1.172	Natural	Natural
IW314	24196	4.583	1702	1548	33.6	2.1754		33.6		33.6	B	1.383	1.151	1.342	1.113	Natural	Urban
IW318	13854	2.624	1726	1636	34.3	0.5832		34.3		34.3	B	0.942	1.018	0.863	0.924	Natural	Natural
IW322	29694	5.624	1812	1614	35.2	1.8923		35.2		35.2	B	1.442	1.537	1.371	1.453	Natural	Natural

[a] Adjusted length used for Tc calculation
[b] Adjusted slope used
[c] S-Graphs used (***** used to identify S-Graph basins)
[d] Adjusted length and slope used
[e] Roughness classes determined based on Hydrology Manual definitions

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
IW326	7473	1.415	1660	1592	48.0	0.3331		48.0		48.0	B	0.588	0.506	0.538	0.459	Natural	Natural
IW330	16152	3.059	1744	1630	37.3	1.0372		37.3		37.3	B	1.058	0.944	1.008	0.895	Natural	Natural
IW334	12266	2.323	1632	1548	36.2	1.2571		36.2		36.2	B	0.838	0.523	0.808	0.503	Natural	Natural
IW338	7098	1.344	1644	1584	44.6	0.3390		44.6		44.6	B	0.575	0.470	0.529	0.428	Natural	Natural
IW342	11257	2.132	1698	1606	43.2	0.3535		43.2		43.2	B	0.888	1.074	0.800	0.957	Natural	Natural
IW346	26458	5.011	1842	1608	46.7	3.4432		46.7		46.7	B	1.254	0.854	1.271	0.866	Natural	Natural
IW349	9959	1.886	1906	1780	66.8	0.2498		66.8		66.8	B	0.650	0.840	0.596	0.763	Natural	Natural
IW350	26115	4.946	1852	1680	34.8	2.1751		34.8		34.8	B	1.363	1.203	1.308	1.150	Natural	Natural
IW351	8979	1.701	1888	1790	57.6	0.3164		57.6		57.6	B	0.642	0.658	0.596	0.615	Natural	Natural
IW352	4164	0.789	1780	1736	55.8	0.0961		55.8		55.8	B	0.421	0.445	0.383	0.401	Natural	Natural
IW353	25008	4.736	1976	1716	54.9	2.8031		54.9		54.9	B	1.004	0.717	0.996	0.710	Natural	Natural
IW354	8758	1.659	1812	1712	60.3	0.3605		60.3		60.3	B	0.550	0.511	0.508	0.468	Natural	Natural
IW356	9366	1.774	1850	1736	64.3	0.2861		64.3		64.3	B	0.579	0.651	0.533	0.594	Natural	Natural
IW357	15742	2.981	2050	1848	67.8	0.7457		67.8		67.8	B	0.742	0.752	0.700	0.705	Natural	Natural
IW358	8063	1.527	1790	1716	48.5	0.1641		48.5		48.5	B	0.683	0.953	0.625	0.863	Natural	Natural
IW359	20045	3.796	1968	1792	46.4	2.9120		46.4		46.4	B	0.979	0.571	0.983	0.574	Natural	Natural
IW360	11142	2.110	1888	1756	62.6	0.8306		62.6		62.6	B	0.683	0.490	0.654	0.467	Urban	Urban
IW361	11395	2.158	1838	1740	45.4	0.3547		45.4		45.4	B	0.804	0.970	0.733	0.876	Urban	Natural
IW362	6905	1.308	1750	1680	53.5	0.1794		53.5		53.5	B	0.525	0.597	0.488	0.550	Natural	Natural
IW363	9983	1.891	1940	1824	61.4	0.6278		61.4		61.4	B	0.563	0.424	0.529	0.396	Natural	Natural
IW364	13961	2.644	1836	1680	59.0	1.1451		59.0		59.0	B	0.683	0.489	0.667	0.475	Natural	Natural
IW365	14686	2.781	2110	1892	78.4	0.4729		78.4		78.4	C	1.113	1.447	1.000	1.285	Natural	Natural

[a] Adjusted length used for Tc calculation
[b] Adjusted slope used
[c] S-Graphs used (***** used to identify S-Graph basins)
[d] Adjusted length and slope used
[e] Roughness classes determined based on Hydrology Manual definitions

Table HY-D.2.3 Time of Concentration

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

	Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b [e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
		[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
	IW366	14409	2.729	2012	1864	54.2	1.0558		54.2		54.2	B	0.796	0.622	0.763	0.593	Natural	Natural
	IW367	2549	0.483	1924	1880	91.2	0.0512		91.2		91.2	C	0.371	0.374	0.338	0.337	Natural	Natural
	IW368	7212	1.366	1980	1872	79.1	0.2907		79.1		79.1	C	0.833	0.784	0.754	0.702	Natural	Natural
	IW369	17914	3.393	2130	1882	73.1	0.7949		73.1		73.1	C	1.271	1.462	1.175	1.340	Natural	Natural
	IW370	20797	3.939	2150	1852	75.7	0.8795		75.7		75.7	B	0.967	1.148	0.917	1.082	Natural	Natural
	IW371	2857	0.541	2002	1964	70.2	0.0529		70.2		70.2	B	0.308	0.327	0.275	0.288	Urban	Urban
	IW372	7532	1.427	1930	1818	78.5	0.3175		78.5		78.5	B	0.479	0.418	0.442	0.382	Natural	Natural
	IW374	7657	1.450	2056	1958	67.6	0.3875		67.6		67.6	B	0.475	0.374	0.442	0.345	Natural	Natural
	IW375	18208	3.448	2052	1806	71.3	0.6582		71.3		71.3	C	1.392	1.824	1.296	1.685	Natural	Natural
	IW377	5891	1.116	2110	2022	78.9	0.1126		78.9		78.9	B	0.442	0.566	0.408	0.519	Natural	Natural
	IW380	13534	2.563	2340	2072	104.6	0.4998		104.6		104.6	B	0.575	0.631	0.533	0.581	Natural	Natural
	IW381	12702	2.406	2086	1940	60.7	0.3841		60.7		60.7	B	0.704	0.873	0.650	0.799	Natural	Natural
	IW382	11526	2.183	2060	1936	56.8	0.6196		56.8		56.8	B	0.688	0.599	0.642	0.555	Urban	Urban
	IW384	3456	0.654	1976	1936	61.1	0.0826		61.1		61.1	B	0.338	0.327	0.308	0.296	Natural	Natural
	IW386	9528	1.805	2160	2040	66.5	0.3732		66.5		66.5	C	0.917	0.945	0.838	0.855	Natural	Natural
	IW387	13341	2.527	2440	2180	102.9	1.3509		102.9		102.9	C	0.921	0.597	0.892	0.576	Natural	Natural
	IW388	15575	2.950	2100	1920	61.0	1.2257		61.0		61.0	C	1.200	0.958	1.133	0.900	Natural	Natural
	IW389	6318	1.197	2160	2054	88.6	0.1312		88.6		88.6	C	0.638	0.825	0.588	0.753	Natural	Natural
	IW390	10762	2.038	2210	2040	83.4	0.3110		83.4		83.4	C	1.021	1.302	0.929	1.173	Natural	Natural
	IW390A	15477	2.931	2460	2155	104.1	0.9003		104.1		104.1	C	1.033	0.963	0.971	0.899	Natural	Natural
b	IW392	10410	1.972	2520	2038	244.5	1.1135		244.5	233.0	233.0	C	0.500	0.278	0.504	0.280	Natural	Natural
b	IW394	27057	5.124	3380	2260	218.6	4.1731		218.6	212.0	212.0	D	1.367	0.857	1.367	0.857	Natural	Natural

[a] Adjusted length used for Tc calculation

[b] Adjusted slope used

[c] S-Graphs used (***** used to identify S-Graph basins)

[d] Adjusted length and slope used

[e] Roughness classes determined based on Hydrology Manual definitions

Table HY-D.2.3 Time of Concentration

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

	Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
		[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
[b]	IW395	28919	5.477	3840	2390	264.7	7.8618		264.7	240.0	240.0	D	1.267	0.579	1.296	0.594	Natural	Natural
	IW396	14427	2.732	2460	2170	106.1	0.5863		106.1		106.1	C	1.113	1.262	1.017	1.142	Natural	Natural
[b]	IW397	27120	5.136	4160	2840	257.0	4.8148		257.0	240.0	240.0	D	1.217	0.695	1.213	0.693	Natural	Natural
[a]	PD700	11408	2.161	1340	1302	17.6	1.3998	0.815	46.6		46.6	B	0.708	0.386	0.700	0.381	Natural	Natural
	PD704	7321	1.386	1396	1334	44.7	0.3620		44.7		44.7	B	0.583	0.471	0.571	0.460	Natural	Urban
	PD708	20407	3.865	1524	1348	45.5	2.4019		45.5		45.5	B	1.058	0.705	1.046	0.696	Natural	Natural
	PD712	10292	1.949	1590	1348	124.2	0.8916		124.2		124.2	D	0.942	0.630	0.879	0.584	Natural	Natural
	PD712A	12355	2.340	1528	1394	57.3	0.7664		57.3		57.3	C	1.238	1.077	1.150	0.993	Natural	Natural
	PD716	12081	2.288	1626	1340	125.0	1.7546		125.0		125.0	B	0.454	0.217	0.488	0.235	Natural	Natural
[a]	PD720	7505	1.421	1338	1314	16.9	0.5945	0.566	42.4		42.4	B	0.596	0.371	0.558	0.345	Natural	Natural
	PD726	9836	1.863	1412	1342	37.6	0.4126		37.6		37.6	B	0.833	0.823	0.758	0.742	Natural	Natural
	PD726A	14289	2.706	1524	1396	47.3	1.1030		47.3		47.3	C	1.500	1.258	1.471	1.191	Natural	Natural
[c]	PD726B	11400	2.159	1508	1402	49.1	0.9345		49.1		49.1	*****[c]	*****[c]	*****[c]	*****[c]	*****[c]	*****[c]	*****[c]
	PD732	6439	1.220	1544	1464	65.6	0.4793		65.6		65.6	C	0.738	0.470	0.675	0.426	Natural	Natural
	PD736	15044	2.849	1552	1406	51.2	0.7789		51.2		51.2	C	1.500	1.637	1.500	1.546	Natural	Natural
[c]	PD740	11243	2.129	1538	1436	47.9	1.2839		47.9		47.9	*****[c]	*****[c]	*****[c]	*****[c]	*****[c]	*****[c]	*****[c]
[a]	PD744	11909	2.255	1414	1344	31.0	0.7975	1.875	37.3		37.3	B	0.908	0.725	0.850	0.674	Natural	Natural
[b]	PD748	5366	1.016	1908	1516	385.7	0.2838		385.7	282.0	282.0	D	0.450	0.317	0.417	0.291	Natural	Natural
[b]	PD752	4956	0.939	2044	1536	541.2	0.1897		541.2	310.0	310.0	D	0.429	0.355	0.388	0.317	Natural	Natural
	PD756	25028	4.740	2224	1516	149.4	3.2304		149.4		149.4	D	1.500	1.093	1.500	1.093	Natural	Natural
[b]	PD760	6784	1.285	1844	1532	242.8	0.8671		242.8	235.0	235.0	D	0.542	0.248	0.533	0.244	Natural	Natural
[a]	PI600	7813	1.480	1342	1320	14.9	0.6050	0.403	54.5		54.5	B	0.542	0.341	0.513	0.321	Natural	Urban

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[c] S-Graphs used (***** used to identify S-Graph basins)

[d] Adjusted length and slope used

[e] Roughness classes determined based on Hydrology Manual definitions

Table HY-D.2.3 Time of Concentration

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
PI600A	4796	0.908	1376	1340	39.6	0.5203		39.6		39.6	B	0.450	0.205	0.417	0.188	Natural	Urban
[b] PI603	9536	1.806	1412	1336	42.1	0.5190		42.1		42.1	B	0.738	0.615	0.675	0.558	Natural	Urban
PI604	7549	1.430	1644	1390	177.6	0.3628		177.6		177.6	D	0.688	0.579	0.629	0.525	Urban	Urban
PI606	13056	2.473	1462	1352	44.5	1.0766		44.5		44.5	B	0.879	0.635	0.842	0.605	Urban	Urban
PI606A	9420	1.784	1548	1452	53.8	0.4572		53.8		53.8	B	0.667	0.586	0.608	0.529	Natural	Natural
PI609	21691	4.108	1566	1362	49.7	1.9354		49.7		49.7	B	1.146	0.915	1.133	0.904	Urban	Urban
PI612	12622	2.391	1520	1410	46.0	0.7378		46.0		46.0	B	0.883	0.770	0.821	0.710	Natural	Natural
PI615	11492	2.177	1558	1450	49.6	0.8419		49.6		49.6	B	0.771	0.570	0.725	0.532	Urban	Urban
PI618	6425	1.217	1558	1490	55.9	0.2886		55.9		55.9	B	0.500	0.407	0.463	0.374	Natural	Natural
PI621	11523	2.182	1418	1342	34.8	0.9051		34.8		34.8	B	0.900	0.650	0.850	0.610	Natural	Urban
[a] PI624	13858	2.625	1400	1342	22.1	1.2251	2.008	28.9		28.9	B	1.021	0.730	0.963	0.684	Urban	Urban
PI624A	19404	3.675	1540	1392	40.3	2.8067		40.3		40.3	B	1.171	0.693	1.229	0.732	Natural	Urban
PI628	6878	1.303	1548	1486	47.6	0.5695		47.6		47.6	B	0.538	0.316	0.500	0.292	Natural	Natural
[a] PI633	8600	1.629	1342	1322	12.3	0.3359	0.529	37.8		37.8	B	0.708	0.635	0.667	0.649	Natural	Urban
[a] PI635	8372	1.586	1368	1326	26.5	0.6106	1.185	35.4		35.4	B	0.683	0.465	0.638	0.430	Natural	Natural
PI636	7883	1.493	1392	1342	33.5	0.4286		33.5		33.5	B	0.708	0.564	0.646	0.509	Natural	Urban
PI639	11255	2.132	1452	1374	36.6	0.3431		36.6		36.6	B	0.946	1.173	0.854	1.047	Natural	Urban
PI642	7008	1.327	1624	1544	60.3	0.2367		60.3		60.3	B	0.583	0.580	0.538	0.530	Urban	Urban
PI645	14012	2.654	1688	1552	51.2	1.5619		51.2		51.2	B	0.863	0.532	0.858	0.529	Natural	Natural
PI645A	22945	4.346	2016	1654	83.3	1.6307		83.3		83.3	C	1.367	1.283	1.288	1.201	Natural	Natural
PI648	20686	3.918	1848	1588	66.4	1.7278		66.4		66.4	C	1.388	1.162	1.317	1.096	Natural	Natural
PI651	10151	1.922	1712	1588	64.5	0.4594		64.5		64.5	C	0.983	0.954	0.892	0.856	Natural	Natural

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[c] S-Graphs used (***** used to identify S-Graph basins)

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[e] Roughness classes determined based on Hydrology Manual definitions

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
PI654	33247	6.297	2210	1660	87.3	4.0277		87.3		87.3	C	1.500	1.196	1.500	1.150	Natural	Natural
PI657	20498	3.882	2070	1732	87.1	0.8697		87.1		87.1	C	1.279	1.558	1.200	1.452	Natural	Natural
PI660	24728	4.683	2160	1732	91.4	0.8393		91.4		91.4	C	1.450	2.124	1.358	1.975	Natural	Natural
PI663	17993	3.408	2310	1944	107.4	0.6041		107.4		107.4	C	1.108	1.474	1.008	1.327	Natural	Natural
PI669	11427	2.164	1672	1546	58.2	0.2856		58.2		58.2	B	0.800	1.094	0.725	0.981	Natural	Natural
PI672	14991	2.839	1706	1544	57.1	1.5104		57.1		57.1	B	0.838	0.554	0.825	0.544	Natural	Natural
PI675	3073	0.582	1574	1546	48.1	0.0628		48.1		48.1	B	0.375	0.391	0.342	0.353	Natural	Natural
PI678	18767	3.554	1798	1568	64.7	0.8324		64.7		64.7	B	0.983	1.112	0.933	1.049	Natural	Urban
PI681	18480	3.500	2100	1786	89.7	0.9914		89.7		89.7	C	1.175	1.212	1.100	1.126	Natural	Natural
PI684	12619	2.390	2240	1980	108.8	0.7361		108.8		108.8	C	0.842	0.731	0.788	0.679	Natural	Natural
PI687	32563	6.167	3270	2160	180.0	7.0093		180.0		180.0	D	1.500	0.868	1.500	0.868	Natural	Natural
[b] PI688	20383	3.860	3320	2490	215.0	3.1968		215.0	208.0	208.0	D	1.121	0.638	1.117	0.635	Natural	Natural
[b] PI689	33171	6.282	4160	2490	265.8	6.7846		265.8	242.0	242.0	D	1.383	0.775	1.392	0.780	Natural	Natural
PI690	15727	2.979	1744	1566	59.8	0.6289		59.8		59.8	B	0.913	1.043	0.871	0.990	Natural	Natural
PI693	10564	2.001	1650	1542	54.0	0.8361		54.0		54.0	B	0.688	0.471	0.654	0.446	Natural	Natural
SV200	14175	2.685	1504	1412	34.3	2.2918		34.3		34.3	B	0.950	0.480	0.954	0.482	Natural	Natural
SV202	16874	3.196	1546	1446	31.3	1.4365		31.3		31.3	B	1.054	0.803	1.017	0.777	Natural	Natural
SV203	2366	0.448	1516	1480	80.3	0.0760		80.3		80.3	B	0.258	0.188	0.233	0.168	Natural	Natural
[b] SV205	10839	2.053	2540	1484	514.4	0.5022		514.4	302.0	302.0	B	0.333	0.288	0.300	0.256	Natural	Natural
[b] SV208	17407	3.297	3140	1488	501.1	1.0674		501.1	301.0	301.0	D	0.971	0.896	0.925	0.849	Natural	Natural
[b] SV210	10699	2.026	2280	1500	384.9	0.7184		384.9	283.0	283.0	B	0.329	0.229	0.313	0.216	Natural	Natural
SV212	24690	4.676	1800	1462	72.3	4.1391		72.3		72.3	B	0.942	0.529	0.979	0.552	Natural	Natural

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[c] S-Graphs used (***** used to identify S-Graph basins)
[d] Adjusted length and slope used
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Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

	Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
		[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
	SV214	14096	2.670	1640	1498	53.2	1.8700		53.2		53.2	B	0.754	0.415	0.754	0.415	Natural	Urban
	SV216	14362	2.720	1684	1530	56.6	1.6268		56.6		56.6	B	0.750	0.454	0.742	0.448	Natural	Natural
	SV218	14735	2.791	1676	1546	46.6	1.2862		46.6		46.6	B	0.863	0.618	0.838	0.598	Natural	Natural
	SV219	11995	2.272	1676	1564	49.3	0.8972		49.3		49.3	B	0.596	0.379	0.683	0.497	Natural	Natural
	SV220	6896	1.306	1546	1498	36.8	0.6004		36.8		36.8	B	0.567	0.326	0.533	0.305	Natural	Urban
b	SV230	12951	2.453	2620	1524	446.8	0.8513		446.8	291.0	291.0	B	0.363	0.270	0.354	0.263	Natural	Natural
b	SV232	22945	4.346	3060	1532	351.6	3.0569		351.6	275.0	275.0	C	0.779	0.471	0.821	0.509	Natural	Natural
	SV236	10295	1.950	1770	1588	93.3	0.5856		93.3		93.3	B	0.558	0.448	0.525	0.419	Natural	Natural
b	SV240	26273	4.976	3090	1628	293.8	3.6651		293.8	260.0	260.0	C	0.925	0.584	0.954	0.605	Natural	Natural
	SV242	6324	1.198	1730	1636	78.5	0.0939		78.5		78.5	B	0.496	0.756	0.458	0.692	Natural	Natural
	SV244	21079	3.992	2170	1632	134.8	0.9461		134.8		134.8	C	1.179	1.388	1.125	1.317	Natural	Natural
	SV246	6139	1.163	1762	1660	87.7	0.1567		87.7		87.7	B	0.404	0.439	0.371	0.399	Natural	Natural
b	SV248	22862	4.330	3250	1738	349.2	1.2718		349.2	275.0	275.0	C	0.896	0.922	0.871	0.894	Natural	Natural
	SV250	6151	1.165	1768	1672	82.4	0.1213		82.4		82.4	B	0.454	0.579	0.417	0.527	Natural	Natural
	SV251	8684	1.645	1815	1672	86.9	0.2675		86.9		86.9	B	0.546	0.597	0.504	0.546	Natural	Natural
	SV252	7589	1.437	1786	1660	87.7	0.1473		87.7		87.7	B	0.517	0.708	0.475	0.645	Natural	Natural
	SV254	4596	0.870	1753	1672	93.1	0.0971		93.1		93.1	B	0.375	0.421	0.333	0.369	Natural	Natural
	SV256	3345	0.633	1769	1706	99.5	0.0604		99.5		99.5	B	0.308	0.344	0.271	0.298	Natural	Urban
b	SV258	13957	2.643	2550	1746	304.2	0.7359		304.2	265.0	265.0	C	0.638	0.582	0.613	0.557	Natural	Natural
	SV260	11890	2.252	1606	1538	30.2	1.2629		30.2		30.2	B	0.875	0.535	0.846	0.515	Natural	Natural
	SV264	20621	3.905	1678	1552	32.3	1.9190		32.3		32.3	B	1.167	0.900	1.121	0.861	Natural	Natural
	SV264A	27055	5.124	1716	1562	30.1	2.8970		30.1		30.1	B	1.413	1.094	1.358	1.048	Natural	Natural

[a] Adjusted length used for Tc calculation
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Entellus

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JOB: Wittmann Area Drainage Master Study Update

	Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
		[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
	SV268	13780	2.610	1618	1540	29.9	1.3755		29.9		29.9	B	0.908	0.597	0.871	0.570	Natural	Natural
	SV272	14449	2.736	1668	1568	36.5	1.2010		36.5		36.5	B	0.921	0.680	0.883	0.650	Natural	Natural
	SV276	15413	2.919	1666	1558	37.0	0.9233		37.0		37.0	B	0.958	0.870	0.900	0.812	Natural	Natural
	SV280	17827	3.376	1666	1554	33.2	1.0563		33.2		33.2	B	1.088	1.042	1.021	0.971	Natural	Natural
	SV284	6288	1.191	1690	1648	35.3	0.2834		35.3		35.3	B	0.567	0.465	0.521	0.423	Natural	Natural
	SV286	17472	3.309	1784	1668	35.1	1.5380		35.1		35.1	B	1.029	0.779	0.992	0.747	Natural	Urban
	SV290	12131	2.298	1740	1656	36.6	0.8137		36.6		36.6	B	0.854	0.680	0.800	0.632	Natural	Natural
	SV294	26156	4.954	1832	1650	36.7	2.6465		36.7		36.7	B	1.242	0.972	1.192	0.928	Natural	Natural
	SV298	24265	4.596	1812	1648	35.7	1.0753		35.7		35.7	B	1.325	1.644	1.242	1.529	Natural	Natural
	TW400	27511	5.210	1488	1334	29.6	4.2709	5.082	30.3		30.3	B	1.463	0.924	1.483	0.938	Urban	Urban
	TW402	25408	4.812	1496	1338	32.8	4.9144		32.8		32.8	B	1.342	0.727	1.367	0.742	Natural	Urban
a	TW404	13907	2.634	1480	1332	56.2	2.0927	2.050	72.2		72.2	B	0.638	0.320	0.667	0.336	Natural	Urban
b	TW406	3030	0.574	1720	1452	467.0	0.1633		467.0	300.0	300.0	B	0.179	0.099	0.163	0.089	Natural	Natural
b	TW408	20229	3.831	3160	1456	444.8	0.9101		444.8	289.0	289.0	D	1.129	1.308	1.058	1.218	Natural	Natural
	TW410	9964	1.887	1464	1390	39.2	0.3080		39.2		39.2	B	0.813	0.925	0.775	0.907	Natural	Urban
	TW412	20690	3.919	1518	1388	33.2	2.0637		33.2		33.2	B	1.238	0.925	1.200	0.894	Natural	Urban
b	TW414	11243	2.129	2360	1464	420.8	1.1684		420.8	288.0	288.0	B	0.329	0.181	0.338	0.186	Natural	Urban
	TW416	12097	2.291	1556	1488	29.7	0.5883		29.7		29.7	B	0.929	0.896	0.838	0.798	Urban	Urban
	TW418	12099	2.292	1558	1488	30.5	1.3681		30.5		30.5	B	0.833	0.491	0.800	0.469	Natural	Urban
	TW420	12533	2.374	1534	1452	34.5	0.8077		34.5		34.5	B	0.925	0.765	0.863	0.708	Natural	Urban
	TW422	12249	2.320	1524	1444	34.5	0.7032		34.5		34.5	B	0.908	0.802	0.829	0.720	Natural	Urban
	TW424	9604	1.819	1546	1472	40.7	1.4967		40.7		40.7	B	0.617	0.277	0.625	0.282	Urban	Urban

[a] Adjusted length used for Tc calculation
[b] Adjusted slope used
[c] S-Graphs used (***** used to identify S-Graph basins)
[d] Adjusted length and slope used
[e] Roughness classes determined based on Hydrology Manual definitions

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi²]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
TW429	10305	1.952	1624	1554	35.9	0.5553		35.9		35.9	B	0.746	0.638	0.692	0.587	Urban	Urban
[a] TW430	14765	2.796	1646	1546	35.8	2.4917	2.307	43.3		43.3	B	0.792	0.386	0.800	0.391	Natural	Natural
TW431	14230	2.695	1688	1580	40.1	0.8733		40.1		40.1	B	0.875	0.762	0.825	0.714	Natural	Natural
TW432	14188	2.687	1782	1640	52.8	0.8620		52.8		52.8	B	0.854	0.745	0.808	0.701	Natural	Natural
TW434	10971	2.078	1674	1578	46.2	0.5691		46.2		46.2	B	0.750	0.666	0.696	0.612	Natural	Natural
TW436	10224	1.936	1714	1616	50.6	0.6744		50.6		50.6	B	0.633	0.473	0.600	0.446	Urban	Urban
TW440	3973	0.753	1684	1646	50.5	0.1083		50.5		50.5	B	0.408	0.387	0.375	0.353	Natural	Natural
TW442	8697	1.647	1732	1646	52.2	0.3766		52.2		52.2	B	0.596	0.542	0.550	0.496	Urban	Urban
TW444	8664	1.641	1772	1670	62.2	0.3468		62.2		62.2	B	0.554	0.522	0.508	0.475	Urban	Urban
TW446	10098	1.913	1808	1700	56.5	0.3542		56.5		56.5	B	0.621	0.662	0.571	0.603	Natural	Natural
TW446A	10973	2.078	1904	1756	71.2	0.3372		71.2		71.2	C	0.975	1.200	0.879	1.070	Natural	Natural
TW448	12508	2.369	1948	1776	72.6	0.3469		72.6		72.6	C	1.054	1.430	0.950	1.274	Natural	Natural
TW450	21348	4.043	2020	1740	69.3	1.2535		69.3		69.3	C	1.421	1.469	1.333	1.369	Natural	Natural
TW450A	14391	2.726	2350	2056	107.9	0.8811		107.9		107.9	C	0.917	0.805	0.858	0.749	Natural	Natural
TW450B	7413	1.404	2084	1968	82.6	0.4043		82.6		82.6	C	0.675	0.526	0.625	0.483	Natural	Natural
TW452	11311	2.142	1856	1722	62.6	0.4617		62.6		62.6	C	1.025	1.087	0.925	0.970	Natural	Natural
TW452A	16407	3.107	2405	2048	114.9	1.0764		114.9		114.9	C	0.963	0.842	0.913	0.794	Natural	Natural
TW452B	17219	3.261	2068	1818	76.7	1.0314		76.7		76.7	C	1.213	1.159	1.142	1.084	Natural	Natural
TW454	13215	2.503	2052	1864	75.1	0.3557		75.1		75.1	C	1.250	1.780	1.133	1.596	Natural	Natural
TW456	7348	1.392	2044	1920	89.1	0.1764		89.1		89.1	C	0.746	0.936	0.683	0.849	Natural	Natural
TW458	9903	1.876	2150	1964	99.2	0.6697		99.2		99.2	C	0.733	0.545	0.688	0.507	Natural	Natural
TW459	22494	4.260	2500	2060	103.3	1.0450		103.3		103.3	C	1.413	1.688	1.346	1.600	Natural	Natural

[a] Adjusted length used for Tc calculation
[b] Adjusted slope used
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[d] Adjusted length and slope used
[e] Roughness classes determined based on Hydrology Manual definitions

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
TW460	28510	5.400	2910	2044	160.4	2.3156		160.4		160.4	C	1.250	1.132	1.221	1.103	Natural	Natural
TW462	3969	0.752	2140	2060	106.4	0.0799		106.4		106.4	B	0.296	0.322	0.267	0.287	Natural	Natural
TW478	5622	1.065	1598	1552	43.2	0.2625		43.2		43.2	B	0.458	0.333	0.458	0.351	Urban	Urban
TW480	11437	2.166	1692	1590	47.1	0.7539		47.1		47.1	B	0.700	0.543	0.663	0.511	Urban	Urban
TW482	11502	2.178	1766	1646	55.1	0.7565		55.1		55.1	B	0.704	0.548	0.667	0.516	Natural	Urban
TW484	10510	1.990	1768	1674	47.2	0.3477		47.2		47.2	B	0.733	0.830	0.671	0.752	Urban	Urban
TW485	25285	4.789	2012	1686	68.1	2.3729		68.1		68.1	B	1.013	0.803	1.004	0.795	Natural	Natural
[a] WI500	12378	2.344	1402	1340	26.4	1.0488	2.154	28.8		28.8	B	0.979	0.695	0.933	0.659	Natural	Natural
[a] WI502	16737	3.170	1428	1336	29.0	1.2082	2.967	31.0		31.0	B	1.179	1.004	1.133	0.961	Natural	Natural
[a] WI504	10910	2.066	1390	1336	26.1	1.3495	1.685	32.1		32.1	B	0.796	0.433	0.771	0.417	Natural	Urban
WI506	16618	3.147	1458	1350	34.3	1.5757		34.3		34.3	B	1.083	0.781	1.054	0.758	Urban	Urban
WI508	12621	2.390	1438	1364	31.0	0.6991		31.0		31.0	B	1.021	0.932	0.946	0.856	Natural	Natural
WI510	19908	3.770	1488	1364	32.9	1.2274		32.9		32.9	B	1.313	1.287	1.258	1.228	Natural	Natural
WI510A	11774	2.230	1550	1456	42.2	1.1294		42.2		42.2	B	0.813	0.521	0.783	0.500	Natural	Urban
WI512	14556	2.757	1534	1428	38.5	1.3551		38.5		38.5	B	0.917	0.636	0.888	0.613	Urban	Urban
WI514	6102	1.156	1548	1488	51.9	0.3525		51.9		51.9	B	0.488	0.339	0.450	0.310	Natural	Urban
WI516	4853	0.919	1534	1490	47.9	0.1435		47.9		47.9	B	0.488	0.471	0.450	0.431	Natural	Urban
WI518	8788	1.664	1500	1434	39.7	0.5318		39.7		39.7	B	0.721	0.572	0.638	0.484	Natural	Urban
WI524	12352	2.339	1474	1382	39.3	0.9501		39.3		39.3	B	0.871	0.645	0.825	0.607	Natural	Urban
WI525	15452	2.927	1560	1424	46.5	1.9406		46.5		46.5	B	0.900	0.533	0.896	0.530	Natural	Urban
WI526	4413	0.836	1546	1508	45.5	0.0486		45.5		45.5	B	0.500	0.833	0.463	0.764	Natural	Urban
[a] WI527	9630	1.824	1542	1474	37.3	0.7094	1.726	39.4		39.4	B	0.733	0.516	0.688	0.480	Natural	Urban

[a] Adjusted length used for Tc calculation
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Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
WI528	7347	1.391	1544	1494	35.9	0.3585		35.9		35.9	B	0.679	0.563	0.617	0.506	Natural	Urban
WI529	3873	0.734	1548	1526	30.0	0.1664		30.0		30.0	B	0.479	0.355	0.442	0.324	Natural	Urban
WI530	19476	3.689	1750	1542	56.4	2.3758		56.4		56.4	B	0.971	0.621	1.013	0.651	Natural	Natural
WI532	7839	1.485	1782	1676	71.4	0.3228		71.4		71.4	B	0.475	0.423	0.475	0.423	Natural	Urban
WI534	9108	1.725	1852	1712	81.2	0.4340		81.2		81.2	C	0.767	0.686	0.717	0.636	Natural	Urban
WI536	24561	4.652	2028	1672	76.5	1.3700		76.5		76.5	C	1.467	1.618	1.396	1.532	Natural	Natural
WI538	22852	4.328	1984	1668	73.0	1.4302		73.0		73.0	C	1.438	1.457	1.388	1.401	Natural	Natural
WI538A	14839	2.810	2190	1908	100.3	0.7764		100.3		100.3	C	0.979	0.954	0.913	0.882	Natural	Natural
WI540	18692	3.540	2390	1976	116.9	1.2455		116.9		116.9	C	1.063	0.960	1.008	0.906	Natural	Natural
WI542	18000	3.409	1706	1546	46.9	1.1740	2.977	53.7		53.7	B	1.033	0.934	0.996	0.897	Natural	Urban
WI544	20705	3.921	1896	1628	68.3	1.7938		68.3		68.3	B	0.863	0.671	0.875	0.682	Urban	Urban
WI546	14356	2.719	1860	1678	66.9	0.6051		66.9		66.9	B	0.725	0.767	0.688	0.724	Urban	Urban
WI548	9126	1.728	1976	1832	83.3	0.3084		83.3		83.3	B	0.504	0.524	0.471	0.486	Natural	Natural
WI550	3526	0.668	1584	1542	62.9	0.1426		62.9		62.9	B	0.346	0.250	0.308	0.220	Natural	Urban
WI552	9106	1.725	1644	1560	48.7	0.4131		48.7		48.7	B	0.692	0.629	0.629	0.566	Natural	Urban
WI554	12861	2.436	1718	1594	50.9	1.0438		50.9		50.9	B	0.792	0.568	0.763	0.545	Natural	Urban
WI556	2069	0.392	1728	1694	86.8	0.0781		86.8		86.8	B	0.221	0.140	0.213	0.134	Natural	Urban
WI560	26588	5.036	2044	1688	70.7	3.5624		70.7		70.7	B	0.979	0.639	0.992	0.648	Natural	Natural
WI560A	32924	6.236	3030	1876	185.1	2.0440		185.1		185.1	C	1.317	1.432	1.275	1.394	Natural	Natural
WI562	16143	3.057	2170	1852	104.0	0.8720		104.0		104.0	C	1.029	1.010	0.967	0.942	Natural	Natural
WI564	23492	4.449	2580	1960	139.3	1.8057		139.3		139.3	D	1.500	1.448	1.500	1.385	Natural	Natural
WI566	4387	0.831	2060	1980	96.3	0.1110		96.3		96.3	C	0.500	0.518	0.467	0.479	Natural	Natural

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[c] S-Graphs used (***** used to identify S-Graph basins)
[d] Adjusted length and slope used
[e] Roughness classes determined based on Hydrology Manual definitions

Table HY-D.2.3 Time of Concentration

Entellus

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin	TOC Length	TOC Length	US Elev	DS Elev	Slope	Area	Adjusted Length	TOC adjusted slope	basin adjusted slope	Adjusted Slope	Resistance Coefficient Class K_b[e]	24-hr Tc	24-hr R	6-hr Tc	6-hr R	Existing Time-Area Relation	Future Time-Area Relation
	[ft]	[mi]	[ft]	[ft]	[ft/mi]	[mi^2]	[mi]	[ft/mi]	[ft/mi]	[ft/mi]	[A, B, C, D]	[hr]	[hr]	[hr]	[hr]		
[b] WI570	23861	4.519	3336	1988	298.3	2.2377		298.3	264.0	264.0	D	1.096	0.865	1.063	0.836	Natural	Natural
[b] WI572	29934	5.669	3150	1976	207.1	2.0606		207.1	205.0	205.0	B	0.663	0.622	0.679	0.639	Natural	Natural
WI574	6919	1.310	1928	1836	70.2	0.2190		70.2		70.2	B	0.492	0.496	0.454	0.454	Natural	Natural
WI576	17965	3.402	1968	1734	68.8	1.1801		68.8		68.8	B	0.896	0.794	0.863	0.761	Natural	Natural
WI576A	23736	4.495	2870	2040	184.6	1.2238		184.6		184.6	C	1.083	1.199	1.042	1.148	Natural	Natural
WI576B	9138	1.731	2048	1896	87.8	0.4631		87.8		87.8	C	0.817	0.711	0.750	0.647	Natural	Natural
WI578	11252	2.131	2225	1994	108.4	0.4841		108.4		108.4	C	0.838	0.842	0.767	0.763	Natural	Natural
WI580	13296	2.518	2020	1832	74.7	1.3195		74.7		74.7	B	0.642	0.404	0.646	0.407	Natural	Natural
WI580A	26073	4.938	2940	2024	185.5	2.7850		185.5		185.5	C	1.033	0.768	1.029	0.764	Natural	Natural
[b] WI580B	15228	2.884	3270	2183	376.9	0.6285		376.9	281.0	281.0	C	0.671	0.722	0.625	0.668	Natural	Natural
WI582	8237	1.560	1716	1628	56.4	0.3753		56.4		56.4	B	0.579	0.504	0.538	0.464	Natural	Urban
[a] WI584	14905	2.823	1646	1550	34.0	1.2569	2.420	39.7		39.7	B	0.963	0.714	0.925	0.683	Urban	Urban
[d] WT100	28360	5.371	2980	1336	306.1	3.8475	4.563	360.3	266.0	266.0	C	0.958	0.628	0.983	0.647	Natural	Natural
[d] WT110	22505	4.262	2560	1340	286.2	2.8958	4.201	290.4	258.0	258.0	C	0.846	0.535	0.867	0.549	Natural	Natural
[d] WT120	26273	4.976	2470	1340	227.1	2.8035	4.024	280.8	222.0	222.0	C	1.029	0.766	1.038	0.773	Natural	Natural
[d] WT130	25083	4.751	2970	1350	341.0	2.5672	4.663	347.4	275.0	275.0	C	0.908	0.676	0.921	0.686	Natural	Natural
[b] WT140	29200	5.530	3510	1610	343.6	3.7893		343.6	278.0	278.0	D	1.375	0.969	1.417	1.001	Natural	Natural
[b] WT150	13181	2.496	3040	1530	604.9	1.0865		604.9	313.0	313.0	D	0.771	0.550	0.746	0.530	Natural	Natural
[b] WT150A	27551	5.218	3330	1740	304.7	4.7510		304.7	270.0	270.0	D	1.308	0.769	1.371	0.810	Natural	Natural
[b] WT160	13800	2.614	2920	1540	528.0	0.8127		528.0	308.0	308.0	D	0.829	0.730	0.779	0.681	Natural	Natural

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APPENDIX D.2.3

EXISTING CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
AF800	0.276	0.328	6.447	0.135	1.369
AF802	0.342	0.244	5.222	0.251	4.882
AF803	0.253	0.279	5.068	0.289	24.728
AF805	0.325	0.283	5.475	0.217	3.741
AF807	0.358	0.282	6.738	0.150	0.170
AF810	0.325	0.251	4.419	0.389	10.927
AF820	0.350	0.250	4.217	0.423	5.000
AF830	0.350	0.162	6.880	0.130	5.000
AF850	0.213	0.250	5.050	0.307	44.259
AF852	0.211	0.181	6.691	0.168	42.843
AF854	0.208	0.250	5.078	0.304	43.333
AF860	0.229	0.250	4.023	0.518	35.172
AF862	0.273	0.250	4.025	0.487	24.286
AF864	0.150	0.250	5.594	0.280	55.000
AF866	0.204	0.207	6.431	0.192	44.271
IW300	0.333	0.243	5.605	0.213	5.544
IW302	0.314	0.246	4.918	0.296	12.350
IW310	0.331	0.148	8.143	0.081	6.392
IW312	0.344	0.139	9.923	0.042	6.860
IW314	0.346	0.244	6.048	0.180	5.233
IW318	0.338	0.150	8.597	0.070	7.372
IW322	0.350	0.150	8.622	0.067	5.000
IW326	0.350	0.250	5.374	0.235	5.000
IW330	0.350	0.250	5.701	0.208	5.000
IW334	0.341	0.246	5.789	0.196	5.325
IW338	0.336	0.250	5.780	0.198	6.399
IW342	0.341	0.268	4.586	0.346	5.000
IW346	0.349	0.253	5.005	0.281	5.000
IW349	0.315	0.250	4.804	0.321	13.991
IW350	0.350	0.171	6.789	0.135	5.000
IW351	0.338	0.250	4.426	0.393	7.899
IW352	0.350	0.250	4.511	0.364	5.000
IW353	0.350	0.150	7.596	0.098	5.084
IW354	0.350	0.150	8.086	0.083	5.000
IW356	0.350	0.150	7.178	0.115	5.000
IW357	0.330	0.156	8.059	0.083	11.106
IW358	0.350	0.250	4.638	0.333	5.000
IW359	0.345	0.250	5.939	0.187	6.181
IW360	0.319	0.250	4.127	0.480	13.031
IW361	0.350	0.244	6.061	0.180	5.000
IW362	0.350	0.150	7.223	0.113	5.000
IW363	0.328	0.150	9.339	0.055	11.655
IW364	0.342	0.140	9.898	0.043	7.515
IW365	0.345	0.130	10.100	0.037	6.579
IW366	0.343	0.250	5.762	0.202	7.207
IW367	0.324	0.130	10.100	0.037	12.895

*Ggreen and Ampt parameters are reported to 3 decimal places by WMS, but the actual precision of the data is only 2-3 significant figures.

APPENDIX D.2.3

EXISTING CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
IW368	0.344	0.250	4.000	0.477	6.907
IW369	0.348	0.142	9.869	0.044	5.514
IW370	0.337	0.250	4.616	0.331	7.933
IW371	0.275	0.250	4.150	0.473	26.250
IW372	0.335	0.250	5.001	0.281	9.357
IW374	0.315	0.161	8.147	0.086	12.602
IW375	0.348	0.150	7.035	0.121	5.528
IW377	0.304	0.382	5.921	0.188	5.357
IW380	0.350	0.150	7.161	0.111	5.140
IW381	0.309	0.190	9.152	0.056	11.882
IW382	0.322	0.275	6.319	0.164	8.175
IW384	0.343	0.150	8.675	0.065	7.206
IW386	0.334	0.192	8.439	0.072	5.278
IW387	0.350	0.250	5.656	0.213	7.450
IW388	0.337	0.156	8.775	0.061	9.239
IW389	0.348	0.130	10.100	0.037	5.526
IW390	0.349	0.250	5.071	0.258	5.221
IW390A	0.350	0.250	6.134	0.172	17.033
IW392	0.350	0.150	7.459	0.103	8.347
IW394	0.350	0.327	6.166	0.173	16.632
IW395	0.350	0.374	6.125	0.175	27.313
IW396	0.350	0.250	4.518	0.336	5.192
IW397	0.350	0.381	6.390	0.159	39.233
PD700	0.344	0.246	5.243	0.250	4.918
PD704	0.299	0.297	4.461	0.342	2.516
PD708	0.342	0.245	4.987	0.268	10.121
PD712	0.311	0.250	5.374	0.248	28.595
PD712A	0.350	0.250	4.955	0.280	15.000
PD716	0.348	0.249	5.684	0.209	9.472
PD720	0.341	0.243	5.039	0.275	4.865
PD726	0.335	0.250	4.531	0.353	6.505
PD726A	0.346	0.247	4.501	0.366	8.937
PD726B	0.320	0.250	4.368	0.399	9.751
PD732	0.325	0.232	4.928	0.286	4.645
PD736	0.347	0.248	4.632	0.334	5.248
PD740	0.315	0.242	4.227	0.427	8.181
PD744	0.342	0.249	4.427	0.357	5.989
PD748	0.350	0.283	4.527	0.356	31.290
PD752	0.325	0.277	4.160	0.413	30.417
PD756	0.349	0.346	4.292	0.415	27.514
PD760	0.344	0.336	5.039	0.275	6.919
PI600	0.342	0.244	5.047	0.268	4.887
PI600A	0.345	0.246	5.184	0.252	4.929
PI603	0.344	0.250	4.660	0.316	7.957
PI604	0.307	0.250	4.970	0.285	22.848
PI606	0.324	0.250	4.383	0.419	10.725

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APPENDIX D.2.3

EXISTING CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
PI606A	0.308	0.245	4.449	0.378	10.151
PI609	0.321	0.247	4.529	0.368	8.386
PI612	0.337	0.250	4.365	0.400	6.284
PI615	0.299	0.243	4.318	0.409	8.997
PI618	0.281	0.235	4.623	0.332	9.320
PI621	0.347	0.249	4.621	0.339	5.296
PI624	0.234	0.249	4.886	0.341	34.218
PI624A	0.391	0.258	4.467	0.431	3.693
PI628	0.285	0.250	4.560	0.349	8.902
PI633	0.329	0.235	5.231	0.248	4.696
PI635	0.290	0.270	5.391	0.237	15.959
PI636	0.297	0.250	4.650	0.331	20.164
PI639	0.335	0.250	4.598	0.341	9.561
PI642	0.332	0.334	4.103	0.501	4.208
PI645	0.340	0.277	4.166	0.451	4.792
PI645A	0.316	0.154	8.035	0.087	14.307
PI648	0.346	0.160	8.694	0.064	5.156
PI651	0.350	0.173	6.770	0.136	5.000
PI654	0.348	0.150	9.530	0.051	5.671
PI657	0.348	0.139	9.924	0.042	5.669
PI660	0.346	0.150	9.503	0.052	6.086
PI663	0.350	0.150	9.369	0.053	6.578
PI669	0.378	0.248	4.650	0.364	3.929
PI672	0.348	0.248	4.402	0.391	4.918
PI675	0.350	0.250	4.586	0.346	5.000
PI678	0.324	0.252	4.342	0.417	12.003
PI681	0.338	0.156	8.404	0.071	9.157
PI684	0.350	0.150	7.860	0.087	6.444
PI687	0.350	0.360	5.392	0.232	27.265
PI688	0.350	0.390	5.752	0.200	32.193
PI689	0.350	0.377	6.465	0.154	33.445
PI690	0.350	0.250	4.347	0.404	5.000
PI693	0.345	0.247	4.550	0.354	4.932
SV200	0.349	0.250	4.654	0.323	5.221
SV202	0.331	0.153	6.942	0.125	6.369
SV203	0.341	0.250	4.122	0.459	7.679
SV205	0.350	0.277	6.287	0.156	10.092
SV208	0.350	0.319	4.511	0.313	16.724
SV210	0.350	0.250	5.921	0.177	9.038
SV212	0.348	0.259	4.856	0.299	5.172
SV214	0.349	0.249	5.322	0.242	4.982
SV216	0.348	0.250	5.555	0.222	5.678
SV218	0.345	0.246	5.599	0.219	4.927
SV219	0.330	0.185	6.542	0.148	4.721
SV220	0.320	0.195	6.363	0.159	4.564
SV230	0.350	0.264	6.169	0.163	10.472

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APPENDIX D.2.3

EXISTING CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
SV232	0.350	0.350	5.952	0.174	8.610
SV236	0.344	0.291	4.176	0.446	4.689
SV240	0.350	0.365	5.199	0.235	9.424
SV242	0.350	0.304	4.300	0.416	2.308
SV244	0.350	0.311	6.728	0.137	3.116
SV246	0.350	0.159	7.525	0.101	4.750
SV248	0.350	0.357	5.288	0.220	10.629
SV250	0.350	0.250	4.570	0.348	5.000
SV251	0.350	0.250	3.914	0.490	5.000
SV252	0.338	0.250	3.861	0.499	8.516
SV254	0.350	0.250	3.910	0.491	5.000
SV256	0.350	0.269	3.427	0.575	5.000
SV258	0.350	0.343	6.344	0.150	7.423
SV260	0.342	0.229	6.158	0.173	4.892
SV264	0.350	0.150	7.529	0.101	5.012
SV264A	0.343	0.149	7.303	0.111	6.272
SV268	0.336	0.146	8.834	0.060	5.262
SV272	0.345	0.202	6.541	0.152	5.693
SV276	0.347	0.150	7.339	0.109	5.499
SV280	0.336	0.150	8.395	0.075	6.985
SV284	0.335	0.150	7.759	0.098	8.058
SV286	0.350	0.155	6.951	0.125	5.000
SV290	0.349	0.229	6.207	0.172	5.276
SV294	0.349	0.150	8.572	0.068	5.247
SV298	0.342	0.150	8.237	0.081	6.631
TW400	0.313	0.267	5.320	0.244	17.350
TW402	0.335	0.258	5.155	0.251	10.365
TW404	0.347	0.250	4.926	0.261	6.179
TW406	0.343	0.250	5.689	0.208	14.420
TW408	0.349	0.324	4.317	0.353	21.505
TW410	0.348	0.250	4.358	0.373	5.568
TW412	0.332	0.259	5.787	0.198	11.128
TW414	0.347	0.339	5.371	0.216	8.252
TW416	0.148	0.254	5.761	0.250	55.508
TW418	0.219	0.178	6.692	0.161	34.138
TW420	0.340	0.250	5.662	0.215	7.606
TW422	0.293	0.287	5.537	0.221	26.254
TW424	0.313	0.161	6.851	0.145	10.935
TW429	0.321	0.149	8.256	0.078	7.695
TW430	0.334	0.209	6.520	0.150	5.389
TW431	0.344	0.172	7.534	0.103	5.325
TW432	0.338	0.282	5.069	0.275	4.909
TW434	0.352	0.261	5.746	0.208	5.068
TW436	0.312	0.171	7.041	0.126	14.794
TW440	0.327	0.317	5.883	0.190	5.000
TW442	0.320	0.227	6.986	0.123	8.387

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APPENDIX D.2.3

EXISTING CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
TW444	0.285	0.226	6.387	0.172	23.066
TW446	0.326	0.142	9.967	0.041	11.250
TW446A	0.340	0.150	9.190	0.056	19.497
TW448	0.350	0.133	10.036	0.039	6.419
TW450	0.349	0.150	9.593	0.050	7.331
TW450A	0.348	0.150	8.086	0.083	5.465
TW450B	0.343	0.150	8.767	0.061	7.095
TW452	0.341	0.142	9.850	0.044	7.586
TW452A	0.349	0.150	7.883	0.088	5.286
TW452B	0.349	0.150	7.745	0.093	5.326
TW454	0.350	0.250	5.253	0.250	5.103
TW456	0.350	0.249	6.009	0.183	5.000
TW458	0.344	0.150	8.971	0.059	6.768
TW459	0.350	0.249	6.011	0.181	5.065
TW460	0.350	0.250	5.920	0.188	8.897
TW462	0.342	0.146	9.779	0.046	7.400
TW478	0.329	0.193	6.512	0.151	5.664
TW480	0.316	0.166	7.274	0.112	11.804
TW482	0.334	0.254	5.187	0.262	8.939
TW484	0.301	0.249	6.010	0.191	18.414
TW485	0.348	0.251	5.786	0.199	5.349
WI500	0.349	0.250	5.521	0.224	5.124
WI502	0.344	0.251	5.448	0.229	6.516
WI504	0.336	0.250	5.982	0.190	10.285
WI506	0.326	0.250	5.331	0.254	10.467
WI508	0.336	0.252	5.116	0.271	6.720
WI510	0.339	0.274	5.732	0.204	5.364
WI510A	0.337	0.260	4.622	0.338	5.191
WI512	0.308	0.273	5.800	0.204	13.487
WI514	0.322	0.237	5.113	0.264	6.094
WI516	0.297	0.324	4.300	0.416	9.918
WI518	0.338	0.253	5.205	0.256	8.261
WI524	0.347	0.250	4.659	0.322	10.203
WI525	0.330	0.245	4.547	0.361	8.635
WI526	0.350	0.250	4.350	0.403	5.000
WI527	0.328	0.241	4.863	0.296	7.911
WI528	0.296	0.233	4.353	0.398	13.563
WI529	0.246	0.224	4.300	0.408	24.627
WI530	0.348	0.249	4.293	0.415	4.976
WI532	0.350	0.250	5.053	0.275	5.000
WI534	0.320	0.165	9.599	0.050	16.269
WI536	0.328	0.161	9.678	0.049	13.114
WI538	0.336	0.160	8.095	0.082	10.205
WI538A	0.345	0.150	7.801	0.092	9.971
WI540	0.350	0.200	6.497	0.153	24.434
WI542	0.345	0.252	4.299	0.415	6.718

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APPENDIX D.2.3

EXISTING CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
WI544	0.261	0.295	4.302	0.407	38.479
WI546	0.232	0.309	4.480	0.362	49.331
WI548	0.350	0.162	6.881	0.129	5.000
WI550	0.271	0.230	4.300	0.410	20.079
WI552	0.327	0.250	4.373	0.398	11.892
WI554	0.332	0.253	4.497	0.367	10.849
WI556	0.320	0.265	4.399	0.389	16.111
WI560	0.298	0.284	5.108	0.265	23.110
WI560A	0.349	0.250	5.869	0.191	11.973
WI562	0.344	0.155	6.954	0.125	7.052
WI564	0.350	0.250	5.988	0.181	17.920
WI566	0.348	0.210	6.400	0.159	5.682
WI570	0.350	0.164	6.881	0.129	22.117
WI572	0.349	0.228	6.630	0.145	17.629
WI574	0.350	0.250	4.987	0.283	5.000
WI576	0.338	0.274	4.615	0.339	5.000
WI576A	0.349	0.250	5.970	0.185	7.045
WI576B	0.346	0.250	5.665	0.212	6.275
WI578	0.348	0.208	6.424	0.157	5.662
WI580	0.348	0.250	5.076	0.272	5.692
WI580A	0.349	0.216	6.359	0.161	9.712
WI580B	0.350	0.251	5.837	0.193	14.022
WI582	0.343	0.250	5.000	0.281	7.041
WI584	0.323	0.261	5.089	0.270	9.277
WT100	0.346	0.287	4.578	0.316	16.889
WT110	0.350	0.287	4.795	0.285	7.191
WT120	0.350	0.301	5.261	0.243	3.944
WT130	0.350	0.331	4.724	0.282	10.801
WT140	0.350	0.350	4.071	0.385	19.488
WT150	0.350	0.350	4.476	0.316	15.690
WT150A	0.350	0.350	3.950	0.400	20.000
WT160	0.350	0.350	4.390	0.335	17.815

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APPENDIX D.2.3

FUTURE CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
AF800	0.281	0.205	6.447	0.183	20.621
AF802	0.182	0.238	5.222	0.300	45.976
AF803	0.281	0.250	5.068	0.306	21.956
AF805	0.274	0.238	5.475	0.241	16.034
AF807	0.250	0.176	6.738	0.161	30.000
AF810	0.192	0.249	4.419	0.474	50.096
AF820	0.305	0.250	4.217	0.448	16.246
AF830	0.293	0.162	6.880	0.143	19.216
AF850	0.257	0.150	8.334	0.087	69.800
AF852	0.250	0.181	6.691	0.163	45.000
AF854	0.248	0.250	5.078	0.299	45.875
AF860	0.142	0.250	3.906	0.564	67.467
AF862	0.310	0.250	4.025	0.474	17.000
AF864	0.250	0.250	5.594	0.260	35.000
AF866	0.219	0.207	6.431	0.193	54.115
IW300	0.251	0.250	5.605	0.244	32.680
IW302	0.157	0.250	4.918	0.373	62.786
IW310	0.263	0.150	8.143	0.091	27.246
IW312	0.292	0.153	9.923	0.043	12.060
IW314	0.178	0.245	6.048	0.225	53.623
IW318	0.300	0.150	8.597	0.067	10.000
IW322	0.290	0.150	8.622	0.069	17.017
IW326	0.300	0.250	5.374	0.235	10.000
IW330	0.300	0.250	5.701	0.208	10.000
IW334	0.158	0.250	5.789	0.256	60.749
IW338	0.300	0.250	5.780	0.198	10.000
IW342	0.300	0.250	4.586	0.346	10.000
IW346	0.300	0.250	5.005	0.281	10.000
IW349	0.300	0.250	4.804	0.305	10.000
IW350	0.279	0.174	6.789	0.146	24.927
IW351	0.300	0.250	4.426	0.385	10.000
IW352	0.300	0.250	4.511	0.364	10.000
IW353	0.295	0.151	7.596	0.100	13.795
IW354	0.300	0.150	8.086	0.083	10.000
IW356	0.300	0.150	7.178	0.115	10.000
IW357	0.300	0.150	8.059	0.083	10.000
IW358	0.300	0.250	4.638	0.333	10.000
IW359	0.294	0.350	5.939	0.191	10.733
IW360	0.300	0.250	4.127	0.458	10.000
IW361	0.300	0.244	6.061	0.180	10.000
IW362	0.300	0.150	7.223	0.113	10.000
IW363	0.300	0.150	9.339	0.054	10.000
IW364	0.300	0.140	9.898	0.043	10.000
IW365	0.300	0.136	10.100	0.037	9.665
IW366	0.300	0.373	5.752	0.201	5.613
IW367	0.300	0.130	10.100	0.037	10.000

*Green and Ampt parameters are reported to 3 decimals by WMS, but actual precision of the data is only 2-3 significant digits.

APPENDIX D.2.3

FUTURE CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
IW368	0.300	0.250	4.000	0.477	10.000
IW369	0.300	0.147	9.869	0.044	9.714
IW370	0.300	0.257	4.616	0.323	9.638
IW371	0.300	0.281	4.150	0.452	8.438
IW372	0.300	0.250	5.001	0.281	10.000
IW374	0.299	0.177	8.147	0.081	9.006
IW375	0.300	0.150	7.035	0.121	10.000
IW377	0.231	0.295	5.921	0.212	5.000
IW380	0.289	0.318	7.161	0.113	5.000
IW381	0.300	0.182	9.152	0.056	8.559
IW382	0.300	0.225	6.319	0.164	9.799
IW384	0.300	0.150	8.675	0.065	10.000
IW386	0.272	0.247	8.439	0.076	5.062
IW387	0.216	0.271	5.656	0.245	7.450
IW388	0.295	0.172	8.775	0.061	10.881
IW389	0.300	0.220	10.100	0.037	5.000
IW390	0.293	0.353	5.088	0.259	5.000
IW390A	0.252	0.317	6.134	0.188	17.449
IW392	0.300	0.325	7.459	0.103	8.316
IW394	0.234	0.288	6.165	0.193	19.569
IW395	0.211	0.255	6.124	0.203	31.699
IW396	0.209	0.259	4.518	0.372	5.192
IW397	0.200	0.211	6.390	0.188	44.205
PD700	0.280	0.233	5.243	0.248	9.331
PD704	0.267	0.250	4.461	0.432	23.439
PD708	0.289	0.247	4.987	0.285	18.694
PD712	0.275	0.250	5.374	0.246	22.481
PD712A	0.290	0.250	4.955	0.290	20.162
PD716	0.288	0.250	5.684	0.214	13.905
PD720	0.275	0.249	5.039	0.306	21.212
PD726	0.300	0.250	4.531	0.353	10.000
PD726A	0.298	0.249	4.501	0.378	14.734
PD726B	0.298	0.250	4.368	0.401	12.690
PD732	0.277	0.244	4.928	0.302	9.408
PD736	0.300	0.250	4.632	0.334	10.292
PD740	0.300	0.250	4.227	0.429	10.860
PD744	0.298	0.250	4.427	0.360	11.172
PD748	0.287	0.250	4.527	0.366	41.694
PD752	0.300	0.250	4.160	0.422	39.286
PD756	0.264	0.250	4.292	0.456	39.210
PD760	0.279	0.248	5.039	0.306	17.128
PI600	0.275	0.250	5.047	0.303	23.868
PI600A	0.250	0.250	5.184	0.293	30.000
PI603	0.263	0.250	4.660	0.347	28.978
PI604	0.265	0.250	4.970	0.318	40.981
PI606	0.255	0.250	4.383	0.458	32.416

*Green and Ampt parameters are reported to 3 decimals by WMS, but actual precision of the data is only 2-3 significant digits.

APPENDIX D.2.3

FUTURE CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
PI606A	0.300	0.250	4.449	0.379	11.709
PI609	0.275	0.250	4.529	0.391	21.889
PI612	0.248	0.250	4.365	0.461	34.801
PI615	0.297	0.250	4.318	0.415	11.355
PI618	0.300	0.250	4.623	0.336	10.000
PI621	0.247	0.250	4.621	0.401	31.975
PI624	0.227	0.250	4.886	0.362	44.350
PI624A	0.255	0.250	4.467	0.433	32.285
PI628	0.300	0.250	4.560	0.352	10.000
PI633	0.227	0.250	5.231	0.312	48.412
PI635	0.346	0.373	5.391	0.229	1.550
PI636	0.252	0.252	4.650	0.377	34.481
PI639	0.250	0.250	4.598	0.401	35.270
PI642	0.300	0.250	4.103	0.464	10.000
PI645	0.299	0.250	4.166	0.452	11.096
PI645A	0.235	0.215	8.035	0.083	40.469
PI648	0.298	0.150	8.694	0.074	15.026
PI651	0.300	0.173	6.770	0.151	12.941
PI654	0.273	0.153	9.530	0.056	10.492
PI657	0.285	0.139	9.924	0.048	12.598
PI660	0.293	0.169	9.503	0.057	11.166
PI663	0.228	0.180	9.369	0.060	6.521
PI669	0.300	0.250	4.650	0.330	10.000
PI672	0.299	0.251	4.402	0.390	10.417
PI675	0.300	0.250	4.586	0.346	10.000
PI678	0.182	0.329	4.342	0.390	65.294
PI681	0.222	0.206	8.404	0.072	36.316
PI684	0.204	0.156	7.860	0.101	6.304
PI687	0.200	0.250	5.392	0.273	31.530
PI688	0.200	0.250	5.752	0.235	37.161
PI689	0.200	0.204	6.465	0.181	38.436
PI690	0.264	0.274	4.347	0.400	26.923
PI693	0.300	0.250	4.550	0.354	10.000
SV200	0.238	0.250	4.654	0.379	49.235
SV202	0.271	0.156	6.942	0.139	25.272
SV203	0.350	0.350	4.122	0.459	0.000
SV205	0.292	0.311	6.287	0.161	9.587
SV208	0.238	0.263	4.511	0.313	20.439
SV210	0.223	0.281	5.921	0.206	42.628
SV212	0.251	0.250	4.856	0.347	29.689
SV214	0.237	0.250	5.322	0.289	37.473
SV216	0.285	0.250	5.555	0.245	17.810
SV218	0.300	0.250	5.599	0.219	10.000
SV219	0.267	0.197	6.530	0.168	33.275
SV220	0.250	0.214	6.363	0.190	35.000
SV230	0.278	0.279	6.169	0.170	18.871

*Green and Ampt parameters are reported to 3 decimals by WMS, but actual precision of the data is only 2-3 significant digits.

APPENDIX D.2.3

FUTURE CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
SV232	0.238	0.269	5.952	0.188	12.326
SV236	0.247	0.250	4.176	0.491	11.265
SV240	0.203	0.250	5.199	0.259	14.399
SV242	0.246	0.250	4.300	0.456	7.308
SV244	0.224	0.177	6.728	0.154	8.116
SV246	0.292	0.150	7.525	0.102	9.583
SV248	0.218	0.250	5.278	0.238	21.839
SV250	0.300	0.250	4.570	0.348	10.000
SV251	0.300	0.250	3.914	0.490	10.000
SV252	0.283	0.250	3.861	0.514	22.031
SV254	0.250	0.250	3.910	0.570	45.000
SV256	0.250	0.269	3.427	0.581	45.000
SV258	0.239	0.218	6.321	0.169	40.576
SV260	0.293	0.234	6.158	0.202	17.383
SV264	0.285	0.150	7.529	0.106	20.480
SV264A	0.257	0.150	7.303	0.127	40.105
SV268	0.264	0.150	8.834	0.071	29.386
SV272	0.294	0.196	6.541	0.155	14.391
SV276	0.300	0.150	7.339	0.114	11.472
SV280	0.300	0.150	8.395	0.079	11.985
SV284	0.252	0.150	7.759	0.109	43.843
SV286	0.250	0.155	6.953	0.148	45.000
SV290	0.262	0.229	6.207	0.194	36.395
SV294	0.259	0.150	8.572	0.078	38.661
SV298	0.284	0.150	8.237	0.083	21.116
TW400	0.148	0.292	5.320	0.297	69.723
TW402	0.196	0.297	5.155	0.279	55.014
TW404	0.272	0.271	4.926	0.274	27.205
TW406	0.300	0.250	5.689	0.208	17.246
TW408	0.234	0.266	4.317	0.353	24.719
TW410	0.207	0.250	4.358	0.443	47.992
TW412	0.158	0.272	5.787	0.249	68.037
TW414	0.237	0.268	5.371	0.235	10.854
TW416	0.103	0.258	5.761	0.277	80.000
TW418	0.148	0.186	6.692	0.187	66.034
TW420	0.137	0.274	5.662	0.273	71.507
TW422	0.188	0.324	5.537	0.237	62.264
TW424	0.251	0.165	6.851	0.155	34.688
TW429	0.269	0.150	8.256	0.086	25.329
TW430	0.284	0.198	6.520	0.159	18.002
TW431	0.300	0.150	7.534	0.100	10.000
TW432	0.300	0.250	5.069	0.273	10.000
TW434	0.300	0.250	5.746	0.202	10.000
TW436	0.300	0.150	7.041	0.121	10.000
TW440	0.300	0.250	5.883	0.190	10.000
TW442	0.300	0.151	6.986	0.123	10.000

*Green and Ampt parameters are reported to 3 decimals by WMS, but actual precision of the data is only 2-3 significant digits.

APPENDIX D.2.3

FUTURE CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
TW444	0.300	0.211	6.387	0.160	10.000
TW446	0.300	0.137	9.967	0.041	10.000
TW446A	0.300	0.150	9.190	0.056	21.477
TW448	0.300	0.133	10.036	0.039	11.419
TW450	0.300	0.150	9.593	0.050	11.920
TW450A	0.231	0.194	8.086	0.093	5.065
TW450B	0.300	0.152	8.767	0.061	9.916
TW452	0.290	0.142	9.850	0.046	14.828
TW452A	0.201	0.151	7.883	0.103	5.042
TW452B	0.300	0.150	7.745	0.093	10.000
TW454	0.300	0.250	5.253	0.250	10.000
TW456	0.300	0.249	6.009	0.183	10.000
TW458	0.254	0.156	8.971	0.064	7.441
TW459	0.274	0.360	6.011	0.189	5.000
TW460	0.237	0.305	5.920	0.210	8.868
TW462	0.300	0.232	9.779	0.046	5.600
TW478	0.298	0.199	6.512	0.153	11.106
TW480	0.300	0.150	7.274	0.111	10.000
TW482	0.186	0.251	5.187	0.339	64.833
TW484	0.226	0.249	6.010	0.220	44.759
TW485	0.284	0.250	5.786	0.206	17.403
WI500	0.292	0.300	5.521	0.245	24.910
WI502	0.259	0.280	5.443	0.259	35.404
WI504	0.299	0.339	5.982	0.201	27.349
WI506	0.270	0.253	5.331	0.266	28.348
WI508	0.295	0.250	5.116	0.277	13.185
WI510	0.258	0.250	5.732	0.237	27.923
WI510A	0.250	0.250	4.622	0.398	34.980
WI512	0.189	0.250	5.800	0.248	56.187
WI514	0.250	0.250	5.113	0.316	35.250
WI516	0.250	0.250	4.300	0.491	43.689
WI518	0.181	0.250	5.205	0.313	61.130
WI524	0.251	0.250	4.659	0.350	34.581
WI525	0.238	0.250	4.547	0.417	41.266
WI526	0.250	0.250	4.350	0.477	45.000
WI527	0.175	0.250	4.863	0.385	62.057
WI528	0.204	0.250	4.353	0.503	72.188
WI529	0.248	0.250	4.300	0.493	77.463
WI530	0.282	0.260	4.293	0.417	18.470
WI532	0.150	0.360	5.053	0.262	80.000
WI534	0.150	0.252	9.599	0.048	80.000
WI536	0.176	0.233	9.678	0.047	67.554
WI538	0.225	0.224	8.095	0.080	45.221
WI538A	0.235	0.150	7.801	0.102	10.191
WI540	0.200	0.200	6.497	0.181	24.380
WI542	0.237	0.252	4.299	0.499	43.129

*Green and Ampt parameters are reported to 3 decimals by WMS, but actual precision of the data is only 2-3 significant digits.

APPENDIX D.2.3

FUTURE CONDITIONS
BASIN LG CARD SUMMARY

Basin	IA	DTHETA	PSIF	XKSAT	RTIMP*
WI544	0.197	0.318	4.302	0.404	58.005
WI546	0.179	0.331	4.480	0.358	66.468
WI548	0.300	0.162	6.881	0.129	10.000
WI550	0.133	0.250	4.300	0.565	70.000
WI552	0.249	0.250	4.373	0.470	35.270
WI554	0.213	0.258	4.497	0.452	54.278
WI556	0.150	0.350	4.399	0.374	80.000
WI560	0.224	0.309	5.108	0.262	45.096
WI560A	0.299	0.370	5.869	0.192	13.044
WI562	0.284	0.205	6.954	0.129	8.052
WI564	0.238	0.307	5.988	0.200	17.827
WI566	0.300	0.380	6.400	0.159	5.000
WI570	0.266	0.289	6.881	0.138	22.137
WI572	0.282	0.335	6.630	0.149	18.636
WI574	0.300	0.250	4.987	0.283	10.000
WI576	0.300	0.250	4.615	0.339	10.000
WI576A	0.259	0.338	5.970	0.199	6.766
WI576B	0.300	0.250	5.665	0.212	10.000
WI578	0.299	0.376	6.424	0.158	5.417
WI580	0.296	0.250	5.076	0.273	11.316
WI580A	0.297	0.377	6.359	0.162	9.542
WI580B	0.300	0.392	5.837	0.193	14.041
WI582	0.195	0.267	5.000	0.347	63.537
WI584	0.260	0.250	5.089	0.292	23.924
WT100	0.257	0.251	4.578	0.326	24.137
WT110	0.259	0.250	4.795	0.301	13.809
WT120	0.257	0.250	5.261	0.259	8.944
WT130	0.219	0.250	4.724	0.300	15.801
WT140	0.200	0.250	4.071	0.387	24.488
WT150	0.200	0.250	4.476	0.327	20.690
WT150A	0.200	0.250	3.950	0.400	25.000
WT160	0.200	0.250	4.390	0.347	22.815

*Green and Ampt parameters are reported to 3 decimals by WMS, but actual precision of the data is only 2-3 significant digits.

Entellus

SHEET _____ OF _____

BY GLA DATE _____

CHECK RAS DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Basin Tc > 90 Minute Check

There were several basins that defaulted to a Tc value of 90 minutes in WMS. To determine if this was a reasonable assumption one iteration of a manual computation was performed. The rainfall intensity was based on the asuumed Tc value of 90min and was taken from Hydrology Manual. As can be seen from the data below, all basins in question have Tc values that are in the general range of appropriate values.

24-hour

Basin	Assumed Tc [min]	i [in/hr]	L [mi]	S [ft/mi]	Area [acres]	Basin Type	m	b	Kb	Actual Tc [hrs]	Actual Tc [min]
PD726A	90	1.7	2.706	47.3	706	C	-0.025	0.15	0.0788	1.24	74
PD736	90	1.7	2.849	51.2	499	C	-0.025	0.15	0.0826	1.27	76
PD756	90	1.7	4.740	149.4	2067	D	-0.03	0.2	0.1005	1.30	78
PI654	90	1.7	6.297	87.3	2578	C	-0.025	0.15	0.0647	1.41	85
PI687	90	1.7	6.167	180.0	4486	D	-0.03	0.2	0.0904	1.33	80

6-hour

Basin	Assumed Tc [min]	i [in/hr]	L [mi]	S [ft/mi]	Area [acres]	Basin Type	m	b	Kb	Actual Tc [hrs]	Actual Tc [min]
PD736	90	1.7	2.849	51.2	499	C	-0.025	0.15	0.0826	1.27	76
PD756	90	1.7	4.740	149.4	2067	D	-0.03	0.2	0.1005	1.30	78
PI654	90	1.7	6.297	87.3	2578	C	-0.025	0.15	0.0647	1.41	85
PI687	90	1.7	6.167	180.0	4486	D	-0.03	0.2	0.0904	1.33	80
WI564	90	1.7	4.449299	139.3478	1155.642	D	-0.03	0.2	0.1081	1.34	80

D.2.4. Hydraulic length and slope

Details regarding the hydraulic length and slope for each individual subbasin are contained in **Appendix D.2.3**.

Entellus™

HEET ____ OF ____
BY AMH DATE 4/03/04
CHECK ____ DATE ____

CLIENT FCDMC
JOB NAME Withmann ADMSU
JOB NO. 310,032

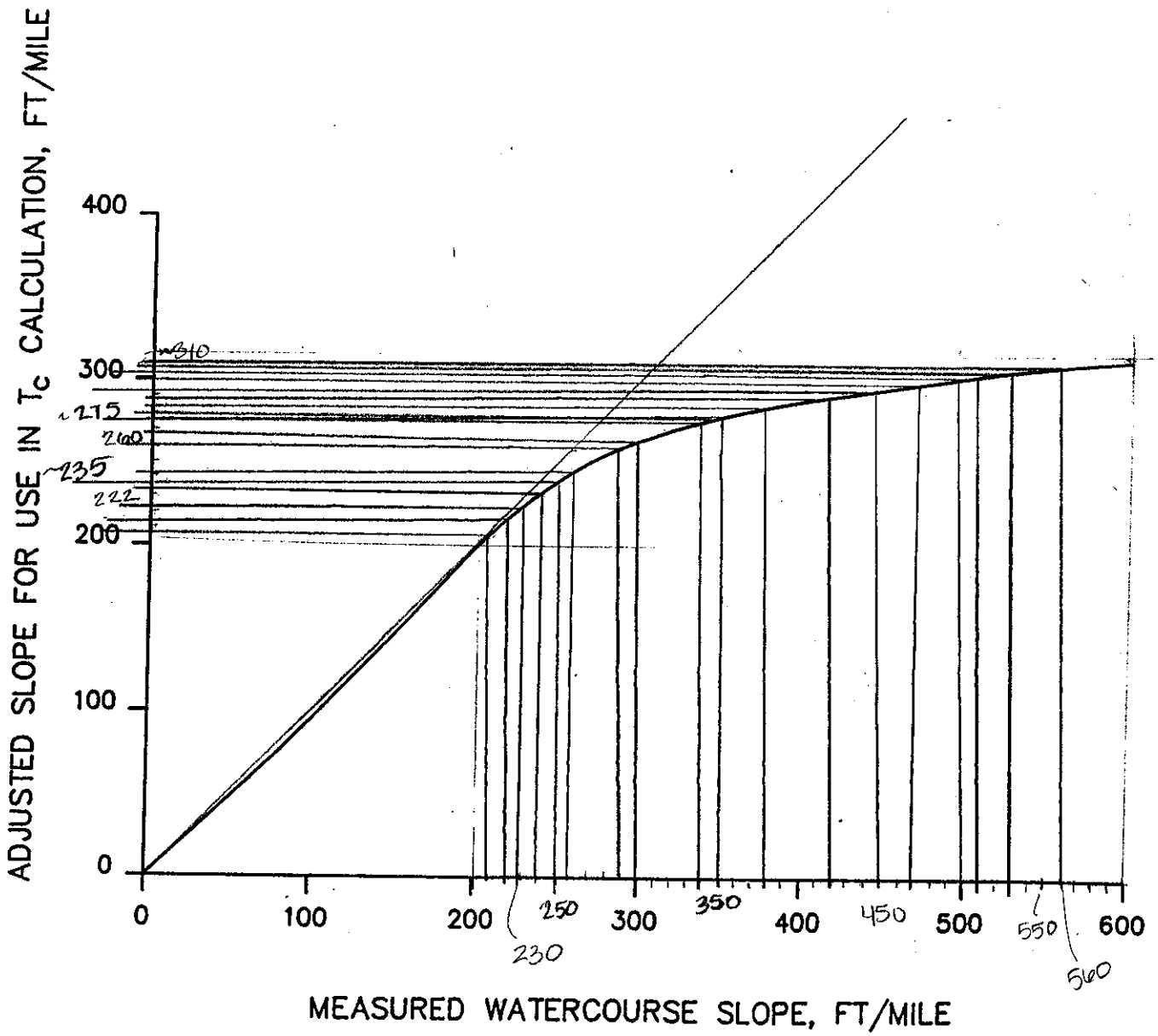


Figure 5.4
Slope Adjustment for Steep Watercourses in Natural Watersheds
(Source: *Drainage Criteria Manual*, Urban Drainage and Flood Control District, Colorado, May 1984.)

D.2.5. S-Graphs

Entellus

SHEET		OF	
BY		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann ADMSU

S-Graph Generation

Per the District's request, S-graphs were used for the two basins directly upstream of Bonita Dam. The Hydrology Manual methodology and procedure was followed for the development of the S-graphs. Desert/Rangeland S-graph types were chosen and the Kn value was taken from Bing Zhao's report '*Hydrologic Study for Bonita Dam – Maricopa County, Arizona*' **(Reference 39)** per the Districts request.

Summary of Lca and Kn values for S-Graphs

Basin ID	Time of Concentration Length (ft)	Time of Concentration Length (miles)	U/S Elev. (ft)	D/S Elev. (ft)	Slope (ft/mile)	K_n	L_{ca} (Miles)	Basin Lag (Hours)
PD740	11243	2.13	1538	1436	47.9	0.059	1.16	0.96
PD726B	11400	2.16	1508	1402	49.1	0.059	0.93	0.88

The following equation, as recommended by the Corp of Engineers was used:

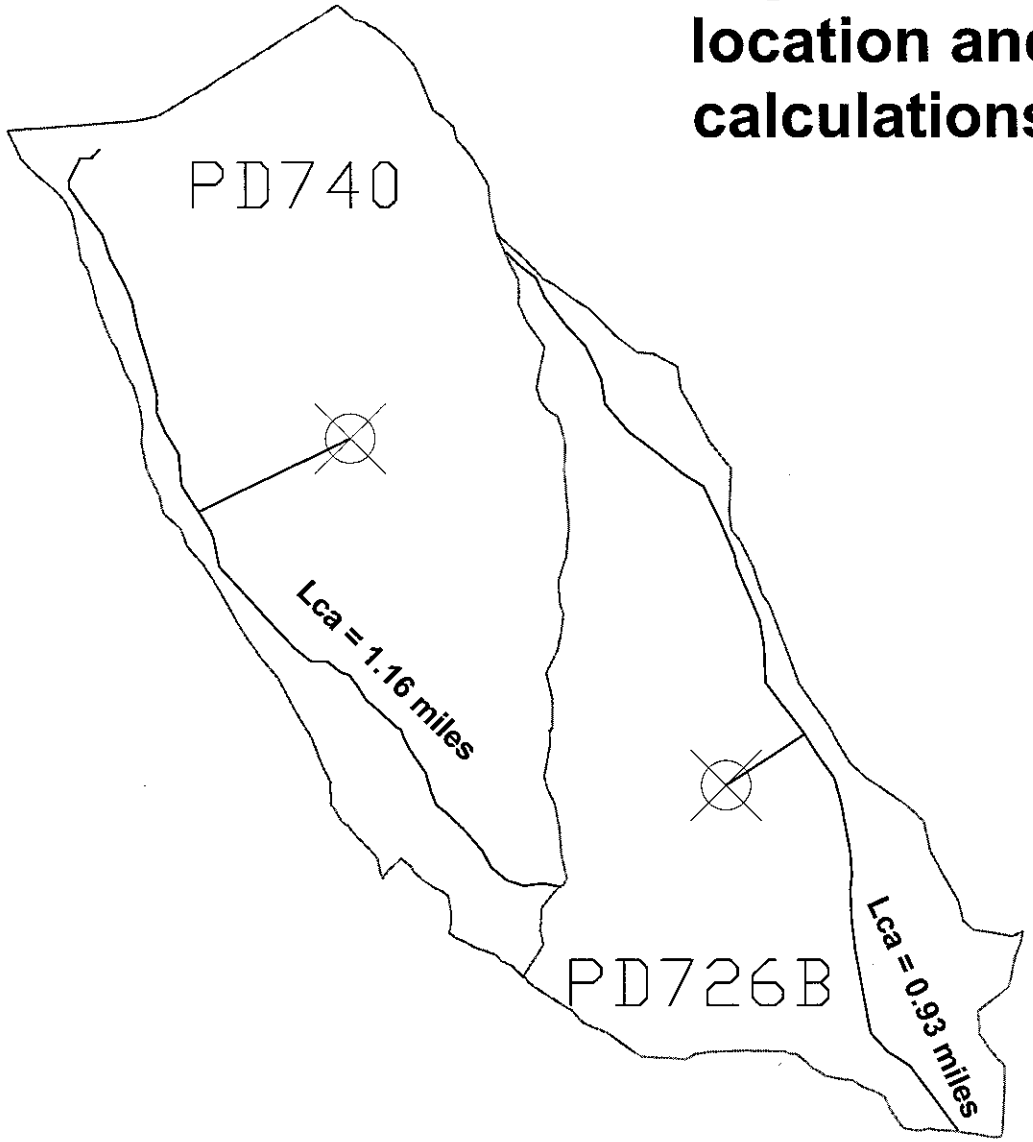
$$Lag = C\left(\frac{L * Lca}{S^p}\right)^m$$

$$C = 24Kn$$

$$m = 0.38$$

$$p = 0.5$$

S-graph centroid location and Lca calculations



Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC

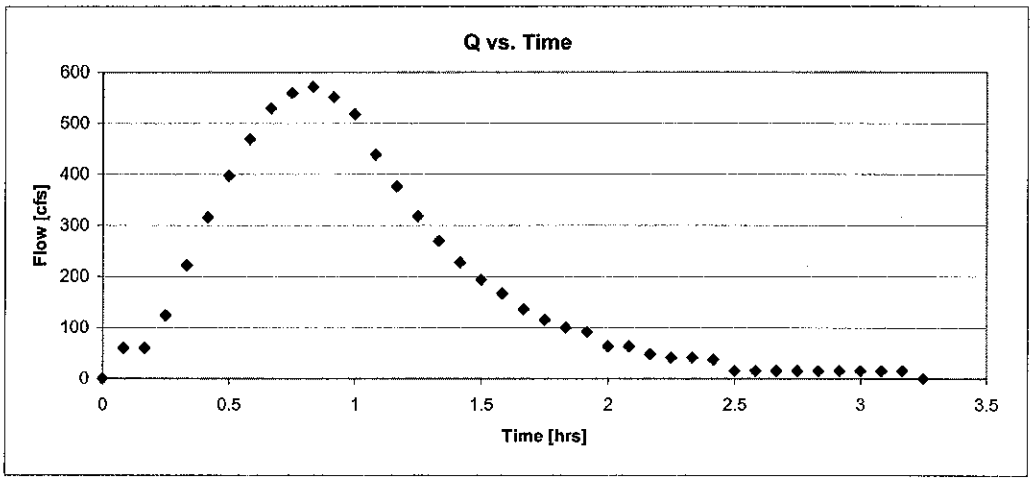
JOB NO. 310.032

JOB: Wittmann ADMSU

S-Graph Parameters

Basin Name	PD726B
Basin Area [mi^2]	0.9345
Basin Lag [hr]	0.88
Time Step [min]	5
Time Step [hr]	0.0833
Q_{ult}	7237
S-Graph Type	Desert/Rangeland

```
UI AND COMMENT CARDS
* Desert/Rangeland S-Graph for Basin PD726B
* Basin Area [mi2] = 0.9345
* Basin Lag [hr] = 0.88
* Time Step [min] = 5
* Qult = 7237
*
UI     0      60      60     123     221     315     397     469     529     559
UI   571     551     518     438     376     317     269     227     193     166
UI   135     115     100      91      63      63      48      41      41      37
UI    15      15      15      15      15      15      15      15      15       0
```



Entellus

SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann ADMSU

Basin Name PD726B

Time (hrs)	Time (min)	% Q_{ult}	Q	% Lag Desert/Rangeland
0.000	0.00	0	0	0.00
0.202	12.14	2	145	23.00
0.273	16.37	4	289	31.00
0.325	19.48	6	434	36.90
0.367	22.02	8	579	41.70
0.404	24.24	10	724	45.90
0.437	26.24	12	868	49.70
0.468	28.09	14	1013	53.20
0.496	29.78	16	1158	56.40
0.525	31.52	18	1303	59.70
0.550	33.00	20	1447	62.50
0.575	34.48	22	1592	65.30
0.598	35.90	24	1737	68.00
0.621	37.28	26	1882	70.60
0.644	38.65	28	2026	73.20
0.666	39.97	30	2171	75.70
0.689	41.34	32	2316	78.30
0.710	42.61	34	2460	80.70
0.731	43.88	36	2605	83.10
0.752	45.14	38	2750	85.50
0.774	46.41	40	2895	87.90
0.795	47.68	42	3039	90.30
0.816	48.95	44	3184	92.70
0.837	50.21	46	3329	95.10
0.858	51.48	48	3474	97.50
0.880	52.80	50	3618	100.00
0.902	54.12	52	3763	102.50
0.925	55.49	54	3908	105.10
0.947	56.81	56	4053	107.60
0.971	58.24	58	4197	110.30
0.994	59.66	60	4342	113.00
1.020	61.20	62	4487	115.90
1.047	62.83	64	4632	119.00
1.076	64.57	66	4776	122.30
1.105	66.32	68	4921	125.60
1.138	68.27	70	5066	129.30
1.172	70.33	72	5210	133.20
1.209	72.55	74	5355	137.40
1.249	74.92	76	5500	141.90
1.292	77.51	78	5645	146.80
1.338	80.31	80	5789	152.10
1.390	83.42	82	5934	158.00
1.448	86.86	84	6079	164.50
1.514	90.82	86	6224	172.00
1.588	95.25	88	6368	180.40
1.678	100.69	90	6513	190.70
1.786	107.13	92	6658	202.90
1.918	115.05	94	6803	217.90
2.108	126.51	96	6947	239.60
2.404	144.27	98	7092	273.23
3.236	194.15	100	7237	367.70

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SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC

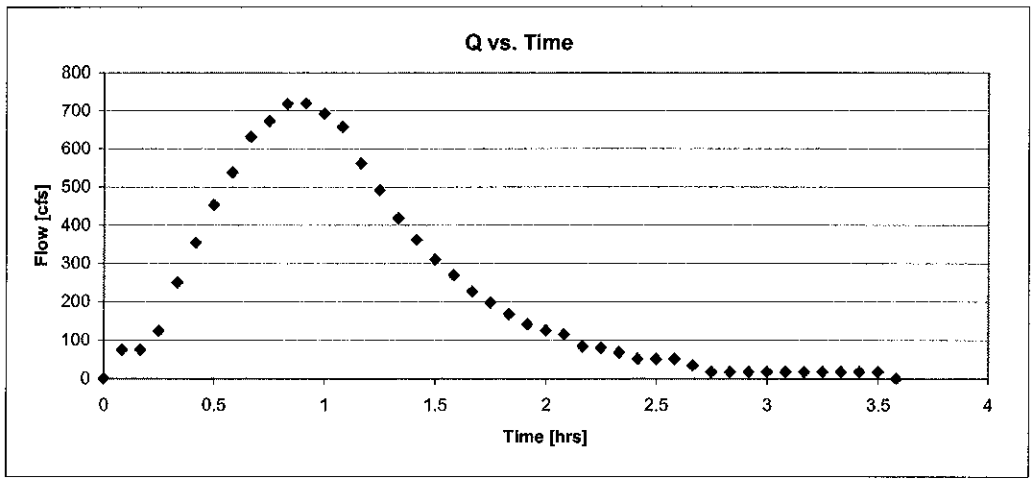
JOB NO. 310.032

JOB: Wittmann ADMSU

S-Graph Parameters

Basin Name	PD740
Basin Area [mi^2]	1.2839
Basin Lag [hr]	0.96
Time Step [min]	5
Time Step [hr]	0.0833
Q_{ult}	9942
S-Graph Type	Desert/Rangeland

```
UI AND COMMENT CARDS
* Desert/Rangeland S-Graph for Basin PD740
* Basin Area [mi2] = 1.2839
* Basin Lag [hr] = 0.96
* Time Step [min] = 5
* Qult = 9942
*
UI     0     75     75    124    249    353    452    537    631    672
UI   718    719    692    657    561    491    417    361    310    269
UI   226    197    167    141    125    115     83     80     68     51
UI    51     51     34     18     18     18     18     18     18     18
UI    18     18     18      0
```



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SHEET _____ OF _____

BY _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann ADMSU

Basin Name PD740

Time (hrs)	Time (min)	% Q_{ult}	Q	% Lag Desert/Rangeland
0.000	0.00	0	0	0.00
0.221	13.25	2	199	23.00
0.298	17.86	4	398	31.00
0.354	21.25	6	597	36.90
0.400	24.02	8	795	41.70
0.441	26.44	10	994	45.90
0.477	28.63	12	1193	49.70
0.511	30.64	14	1392	53.20
0.541	32.49	16	1591	56.40
0.573	34.39	18	1790	59.70
0.600	36.00	20	1988	62.50
0.627	37.61	22	2187	65.30
0.653	39.17	24	2386	68.00
0.678	40.67	26	2585	70.60
0.703	42.16	28	2784	73.20
0.727	43.60	30	2983	75.70
0.752	45.10	32	3182	78.30
0.775	46.48	34	3380	80.70
0.798	47.87	36	3579	83.10
0.821	49.25	38	3778	85.50
0.844	50.63	40	3977	87.90
0.867	52.01	42	4176	90.30
0.890	53.40	44	4375	92.70
0.913	54.78	46	4574	95.10
0.936	56.16	48	4772	97.50
0.960	57.60	50	4971	100.00
0.984	59.04	52	5170	102.50
1.009	60.54	54	5369	105.10
1.033	61.98	56	5568	107.60
1.059	63.53	58	5767	110.30
1.085	65.09	60	5965	113.00
1.113	66.76	62	6164	115.90
1.142	68.54	64	6363	119.00
1.174	70.44	66	6562	122.30
1.206	72.35	68	6761	125.60
1.241	74.48	70	6960	129.30
1.279	76.72	72	7159	133.20
1.319	79.14	74	7357	137.40
1.362	81.73	76	7556	141.90
1.409	84.56	78	7755	146.80
1.460	87.61	80	7954	152.10
1.517	91.01	82	8153	158.00
1.579	94.75	84	8352	164.50
1.651	99.07	86	8551	172.00
1.732	103.91	88	8749	180.40
1.831	109.84	90	8948	190.70
1.948	116.87	92	9147	202.90
2.092	125.51	94	9346	217.90
2.300	138.01	96	9545	239.60
2.623	157.38	98	9744	273.23
3.530	211.80	100	9942	367.70

D.3. Hydrograph Routing Data

D.3.1. Manning's n Value

D.3.2. Cross Section Geometry

D.3.3 NSTEP Check Data: 100-yr 24-hr Existing Conditions

D.3.4 NSTEP Check Data: 100-yr 6-hr Existing Conditions

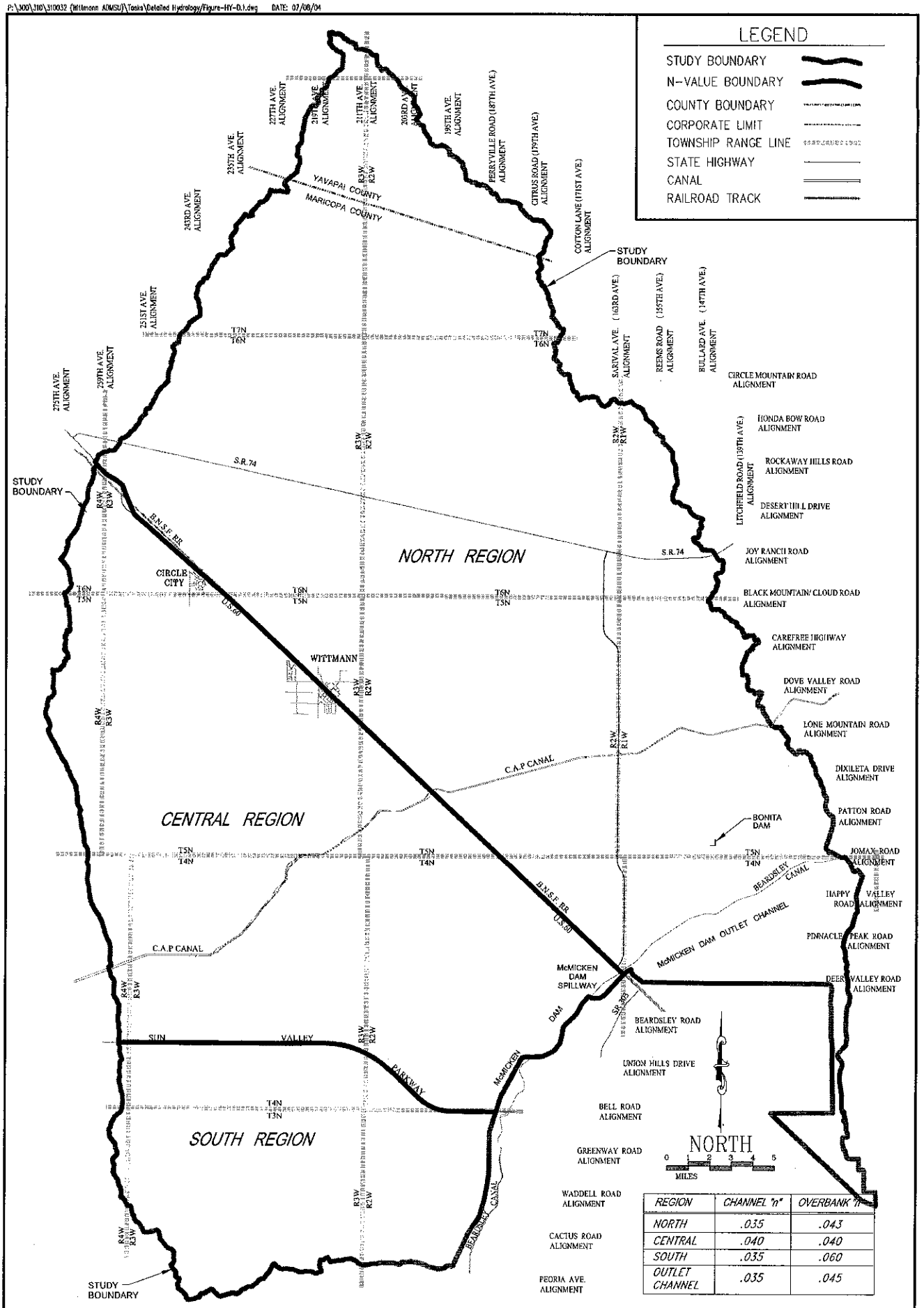
D.3.5 NSTEP Check Data: 100-yr 24-hr Future Conditions

D.3.6 NSTEP Check Data: 100-yr 6-hr Future Conditions

D.3.7 Routing Input Data Summary

D.3.1. Manning's n Value

P:\300\310\310032 (Wittmann ADMSU)\Tasks\Detailed Hydrology/Figure-HY-D.1.dwg DATE: 07/08/04



REGION	CHANNEL "n"	OVERBANK "n"
NORTH	.035	.043
CENTRAL	.040	.040
SOUTH	.035	.060
OUTLET CHANNEL	.035	.045

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Typical "n" Value Regions
FIGURE HY-D.1

Appendix D.3.1

"n" Value Typical Regions Report

1) **Outlet Channel** Region "n" Values

2) **North** Region "n" Values

3) **Central** Region "n" Values

4) **South** Region "n" Values

Outlet Channel Region "n" Values

Appendix D.3.1
Table HY-D.3.1

Project: Wittmann ADMSU
Stream: Channels
Location: Reaches-Southeastern portion of watershed

Channel Conditions		Manning's n Adjustment		Left Overbank (West)	Channel	Right Overbank (East)
Channel Material	Concrete	n_b	.012-.018			
	Firm Soil		.025-.032		0.025	
	Coarse Sand		.026-.035	0.030		0.030
	Gravel		.028-.035			
	Cobble		.030-.050			
	Boulder		.040-.070			
Degree of Irregularity	Smooth	n_1	0	0.000	0.000	0.000
	Minor		.001-.005			
	Moderate		.006-.010			
	Severe		.011-.020			
Effects of Obstruction	Negligible	n_2	.000-.004	0.000	0.000	0.000
	Minor		.005-.015			
	Appreciable		.020-.030			
	Severe		.040-.060			
Vegetation	Small	n_3	.002-.010		0.010	
	Medium		.010-.025	0.015		0.015
	Large		.025-.050			
	Very Large		.050-.100			
Variations in Channel Cross Section	Gradual	n_4	0	0.000	0.000	0.000
	Occ. Alt.		.001-.005			
	Freg. Alt.		.010-.015			
				0.045	0.035	0.045
Degree of Meandering	Minor	m	1	1	1	1
	Appreciable		1.15			
	Severe		1.3			
$n=(n_b+n_1+n_2+n_3+n_4)m$				**0.045**	**0.035**	**0.045**

Appendix D.3.1
Outlet Channels

Looking Downstream of McMicken Channel

Looking Upstream of McMicken Channel

North Region "n" Values

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BY dS DATE
CHECK CSL DATE 4/17/4

CLIENT FCD
JOB NAME Wittmann Aensu JOB NO. 3100

Manning's "n" Value Estimation
- North of US60

NORTH REGION - n-values used for typical sections north of US-60

From WI-TS-90.1

.022	37%	Sandy
.050	63%	Vegetation
.040	0%	Desert Overbank

Weighted Avg = .040

Overbank = .045

From TW-TS-20

.022	75%
.050	25%
.040	0

Weighted average = .029

Overbank = .040

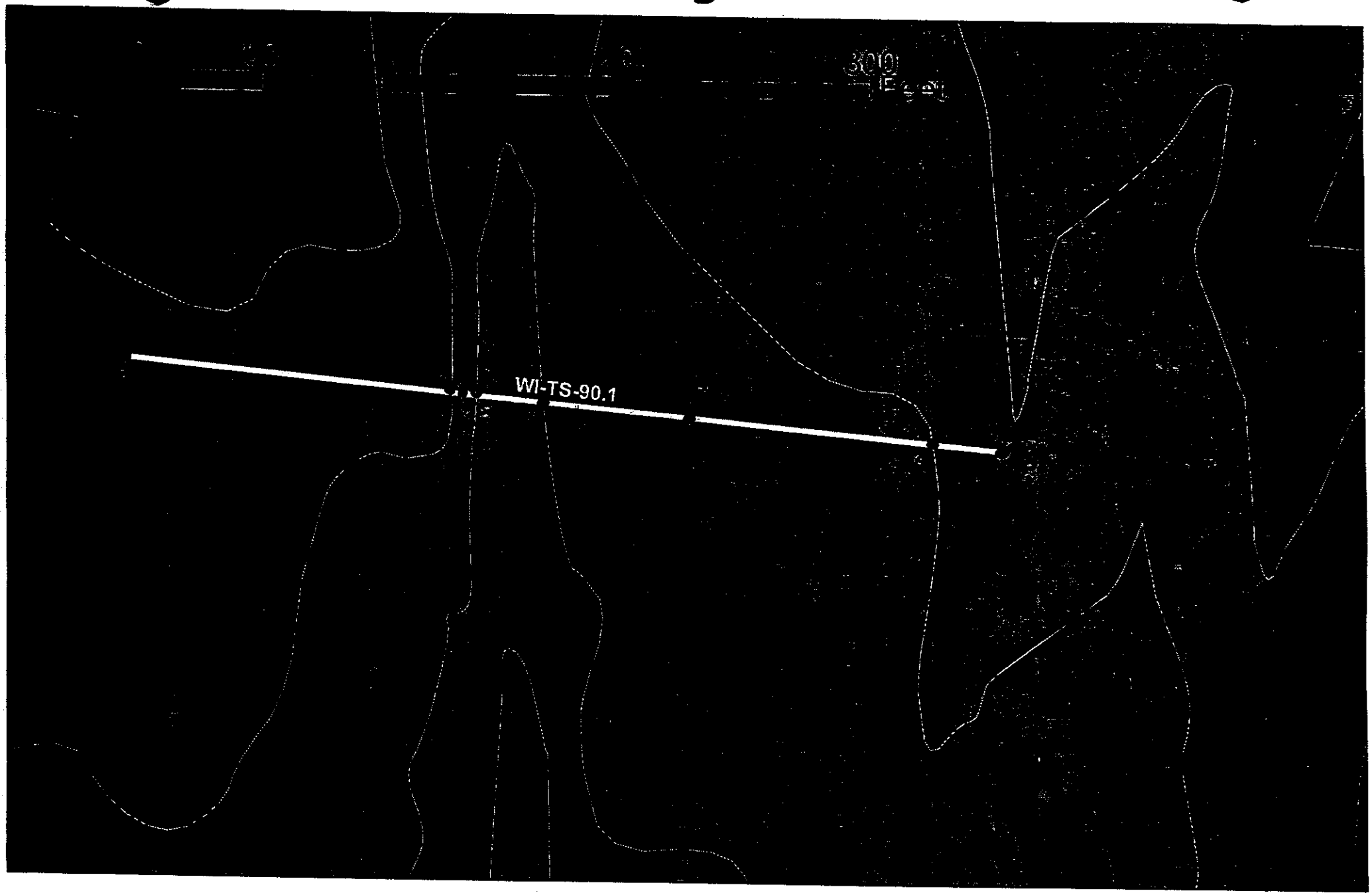
For typical sections north of US60

Channel n-value = $\frac{.029 + .040}{2}$ = .035

Overbank = $\frac{.04 + .045}{}$ = .043

Appendix D.3.1

North Region "n" Values

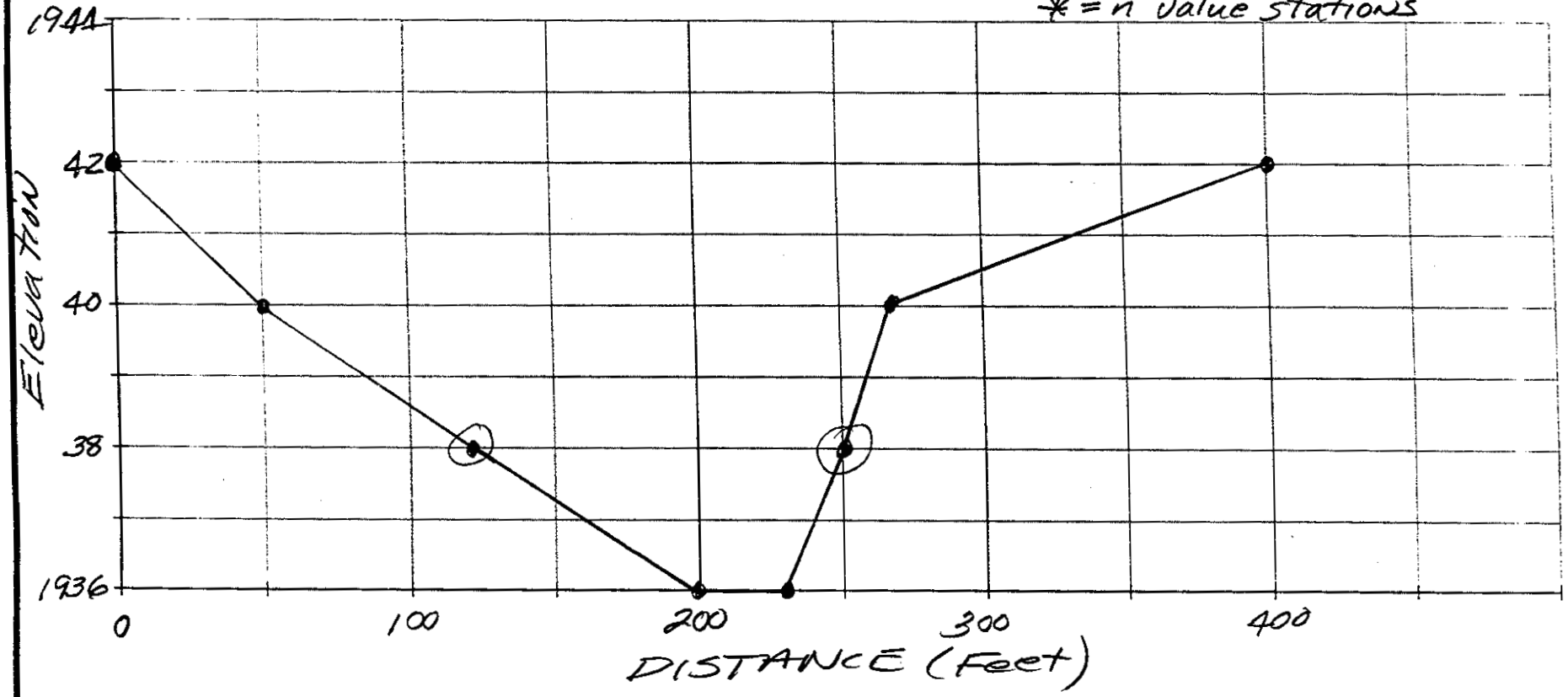

WI-TS-90.1
3000

P:\300\310\310032 ...tion Geometry\PD-TS.dwg

By: JS Date: 2/3/4
Ckd: CJL Date: 4/20/4

Station(ft)	Elevation(ft)
0	1942
30	1940
125	1938 *
200	1936
230	1936
250	1938 *
260	1940
400	1942

* = n value stations



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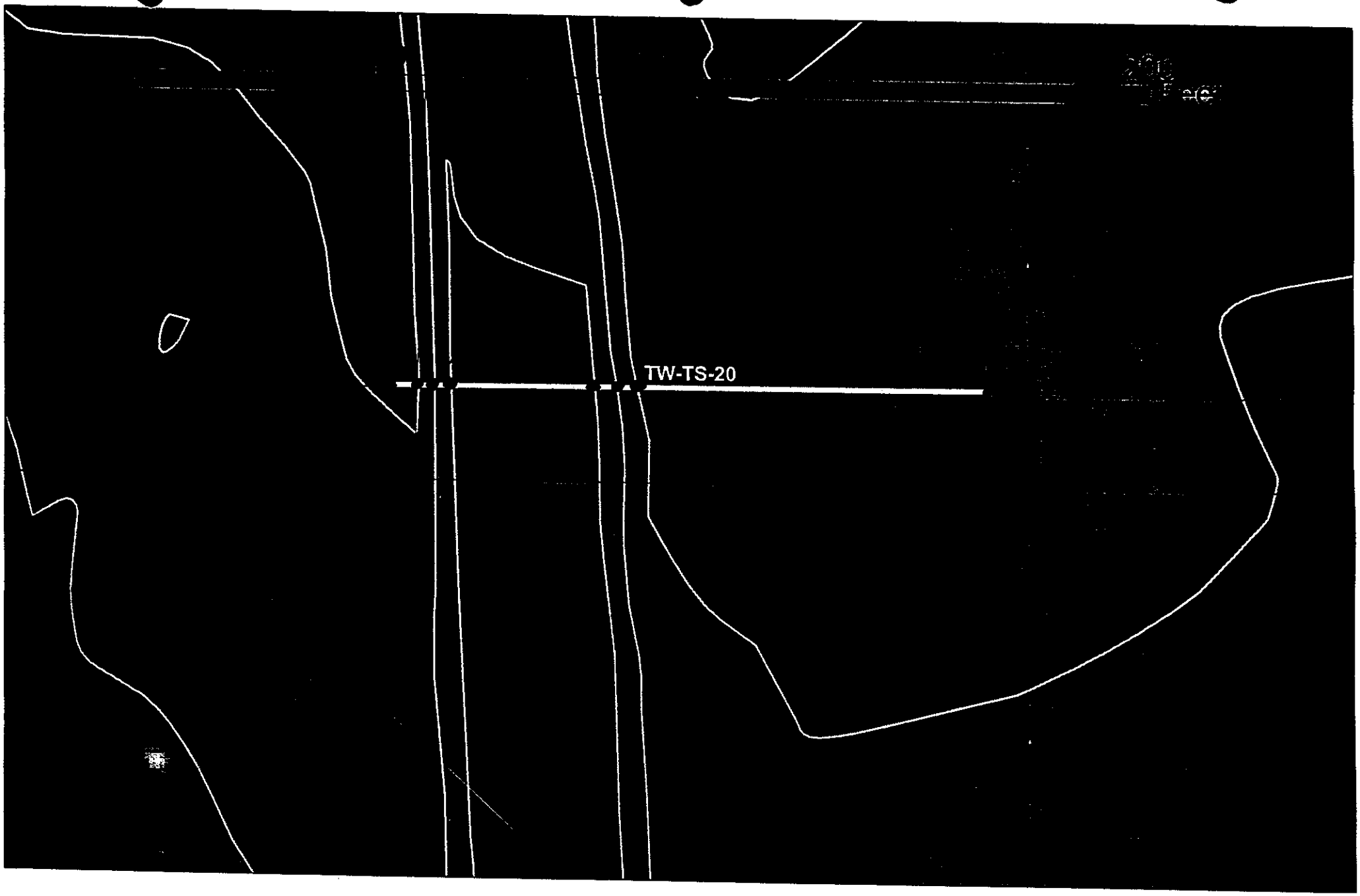
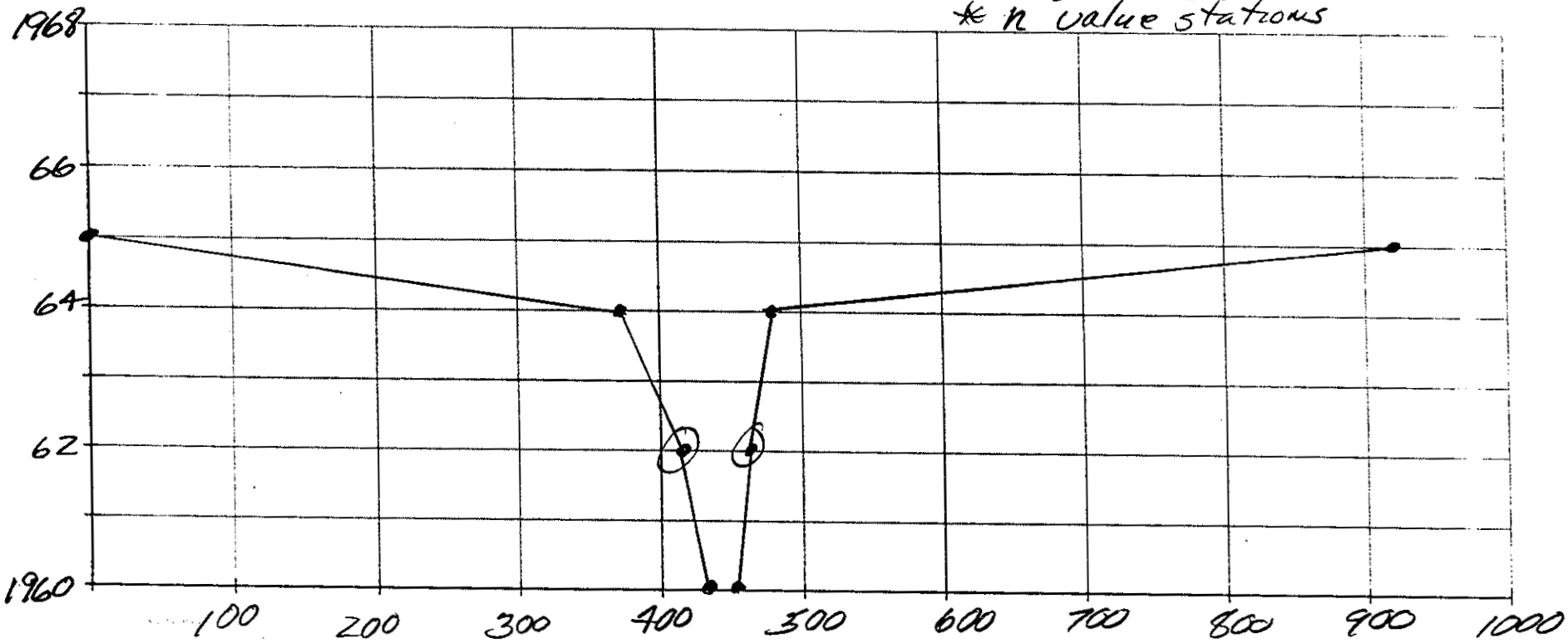
CHANNEL ROUTING TYPICAL CROSS-SECTION
WI-TS-90.1
Date: 4/20/2004


TW-TS-20

By: JS Date: 2/3/4
Ckd: CJL Date: 2/3/4

Station(ft)	Elevation(ft)
0	1965
386	1964
410	62 *
430	60
450	60
460	62 *
471	64
928	65

* n value stations



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CHANNEL ROUTING TYPICAL CROSS-SECTION
TW-TS-20
Date: 4/20/2004

Central Region "n" Values

Entellus™

SHEET ____ OF ____

BY JS DATE 4/11/4

CHECK CSC DATE 4/17/4

CLIENT FCD

JOB NAME Wittmann Comm

JOB NO. 310032

Manning's "n" Value Estimation
Between US60 and Sunwalley Parkway
Class 10:2 CENTRAL REGION: n values used for typical sections between US-60 and Sun Valley Pkwy

From IW-TS-40.1

Channel .022 13% Sandy
.060 32% Dense Vegetation
.040* 55% Desert Overbank

Weighted Average = .044

Overbank = .040*

From IW-TS-30.1

Channel = .035*

Overbank = .040*

For typical sections between US60 and Sunwalley Pkwy,

Channel n value = $\frac{.035 + .044}{2}$ = .040

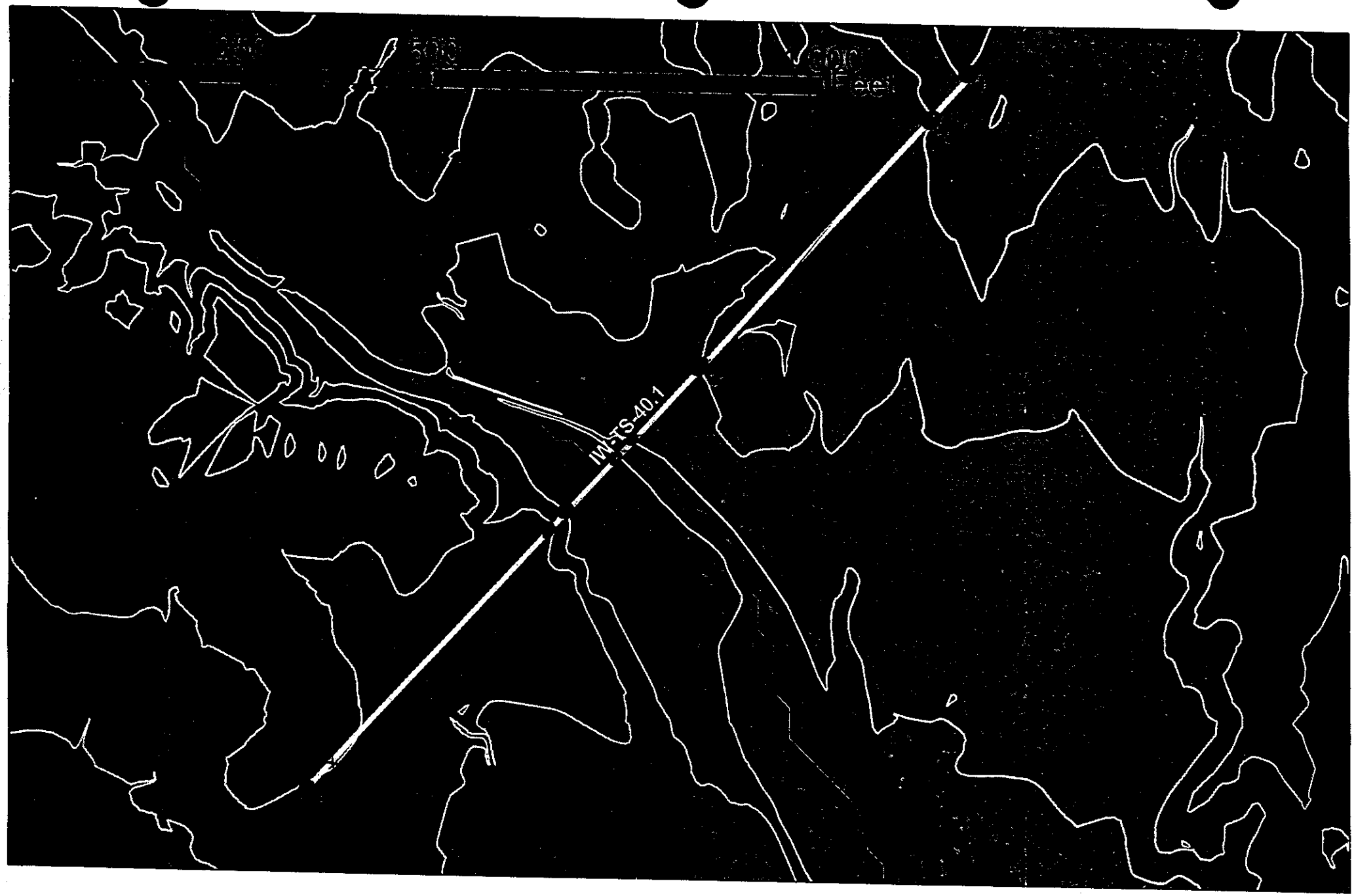
Overbank n value = .04

→ * Values referenced from Table 6.11 of FCD Hydraulics Manual

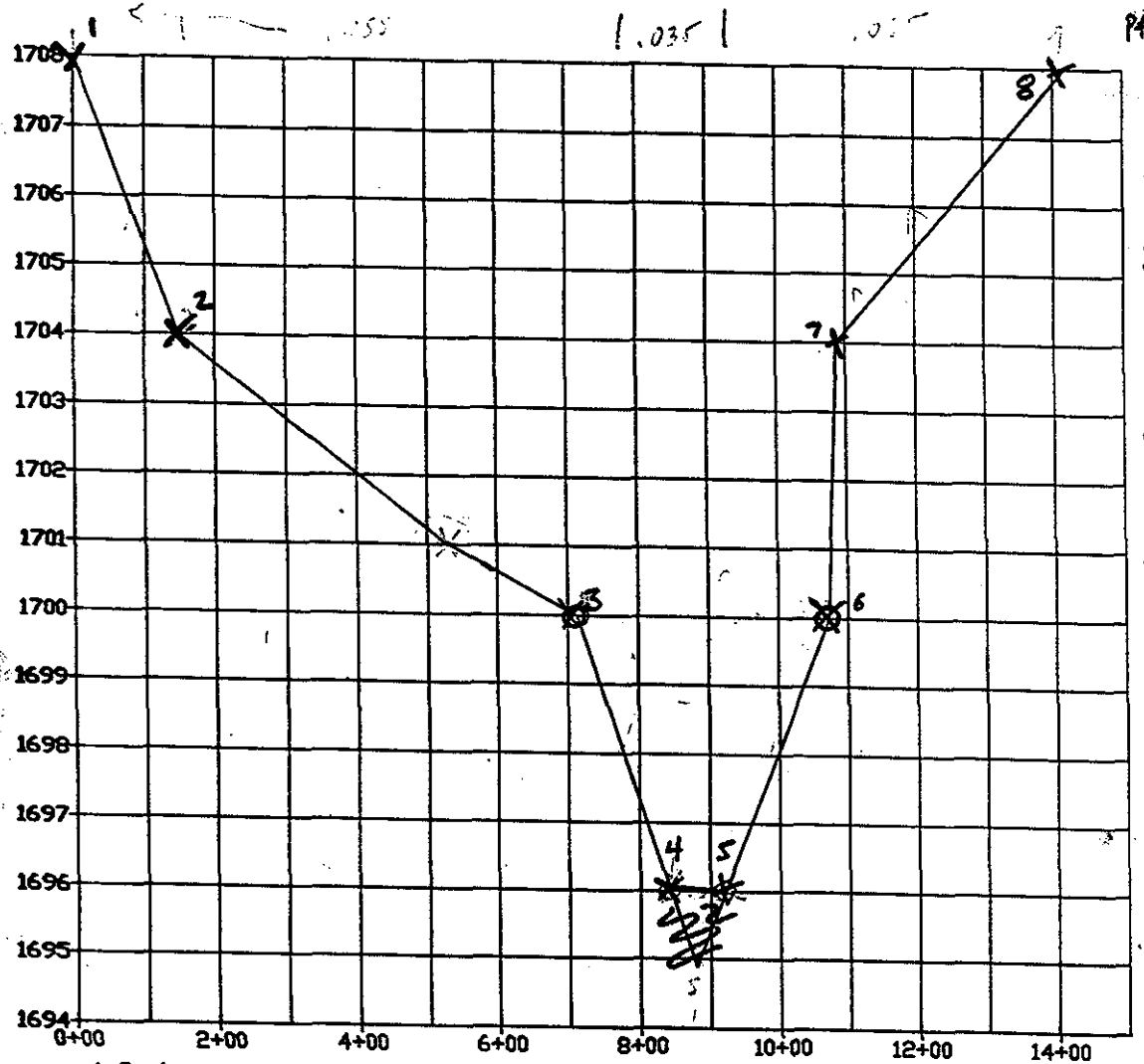
Appendix D.3.1

Central Region "n" Values

IW-TS-40.1



By: JS Date: 2/3/4
Ckd: CSL Date: 2/3/4



	Station [ft]	Elevation [ft]	
1	0	1708	
2	147	1704	
	~~575~~	~~1701~~	
3	714	1700	(n-value station)
	~~880~~	~~1695~~	
6	1073	1700	(n-value station)
7	1087	1704	
8	1417	1708	
4	840	1696	
5	930	1696	

40.1

Class 10: 2

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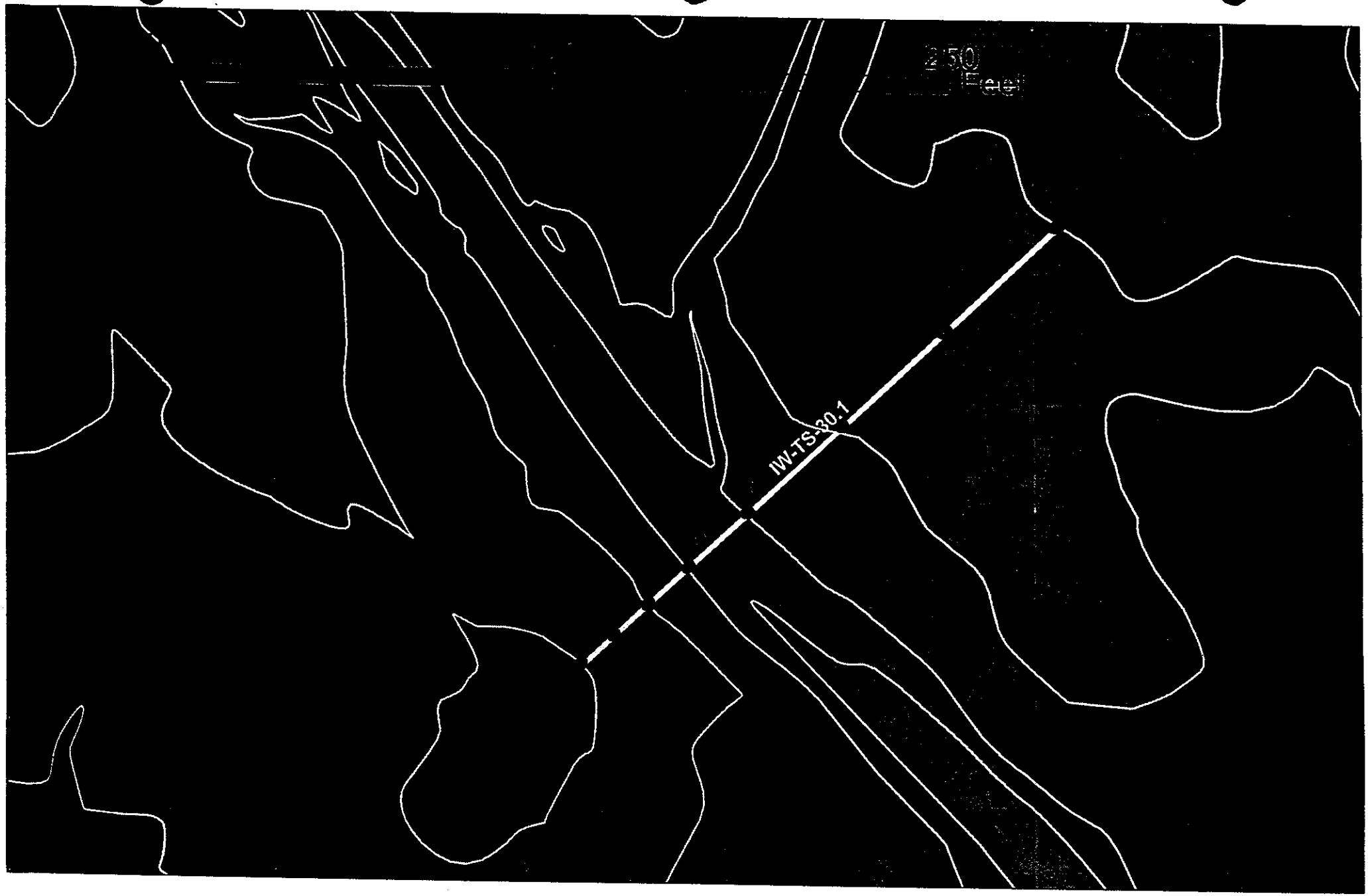
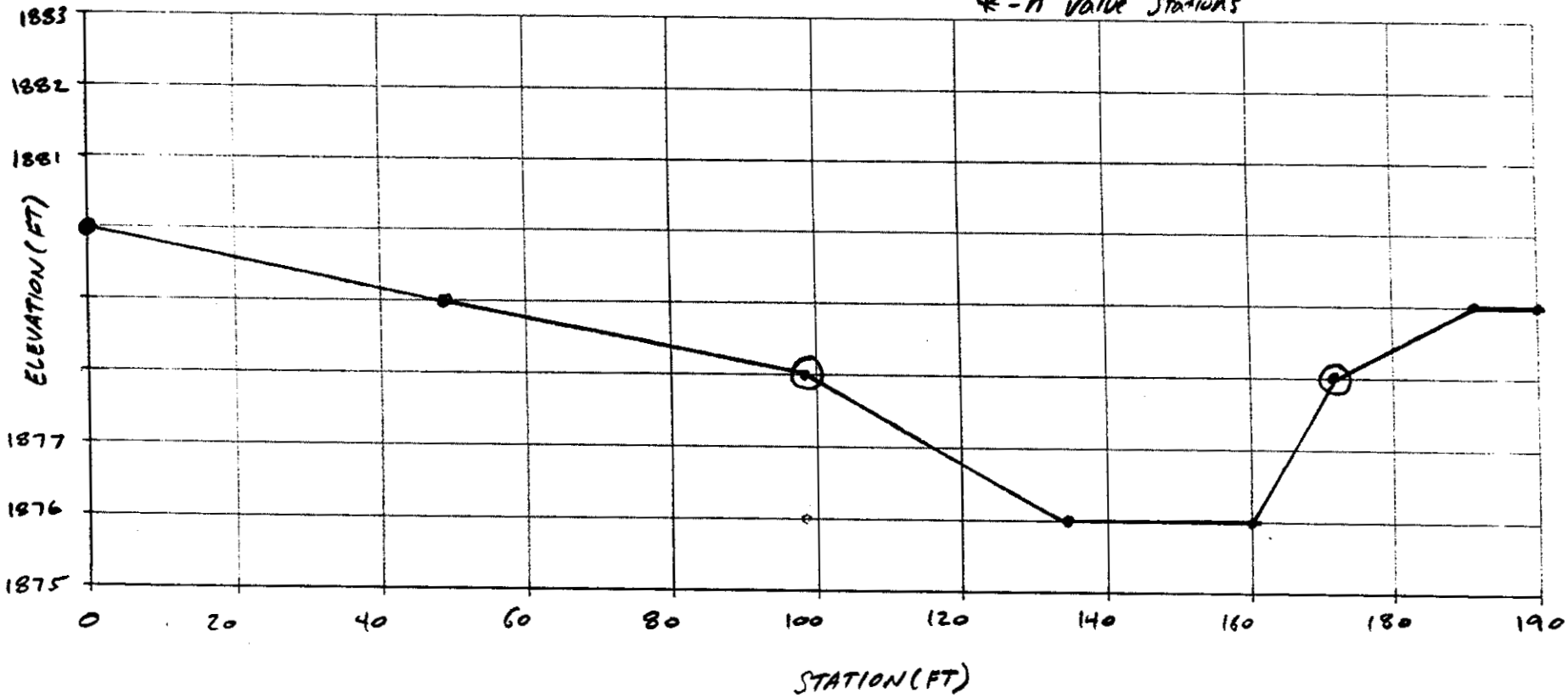
CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-40.1 Date : 9/22/2003 Pg : 7 of 9


250
Feet
IW-TS-30.1

By: JS Date: 2/3/4
Ckd: CJL Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1880	
50	1879	
96	1878	*
135	1876	
160	1876	
177	1878	*
190	1879	
206	1880	

*-n value stations



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CHANNEL ROUTING TYPICAL CROSS-SECTION
IW-TS-30.1
Date: 4/20/2004

South Region "n" Values

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SHEET ____ OF ____

BY W DATE 4/11/4

CHECK CJL DATE 4/17/4

CLIENT FCD

JOB NAME Wittmann Ramsey JOB NO. 310032

SOUTH REGION: n values for typical sections south of Sunvalley Pkwy.

Manning's "n-value Estimation"

South of Sunvalley Parkway

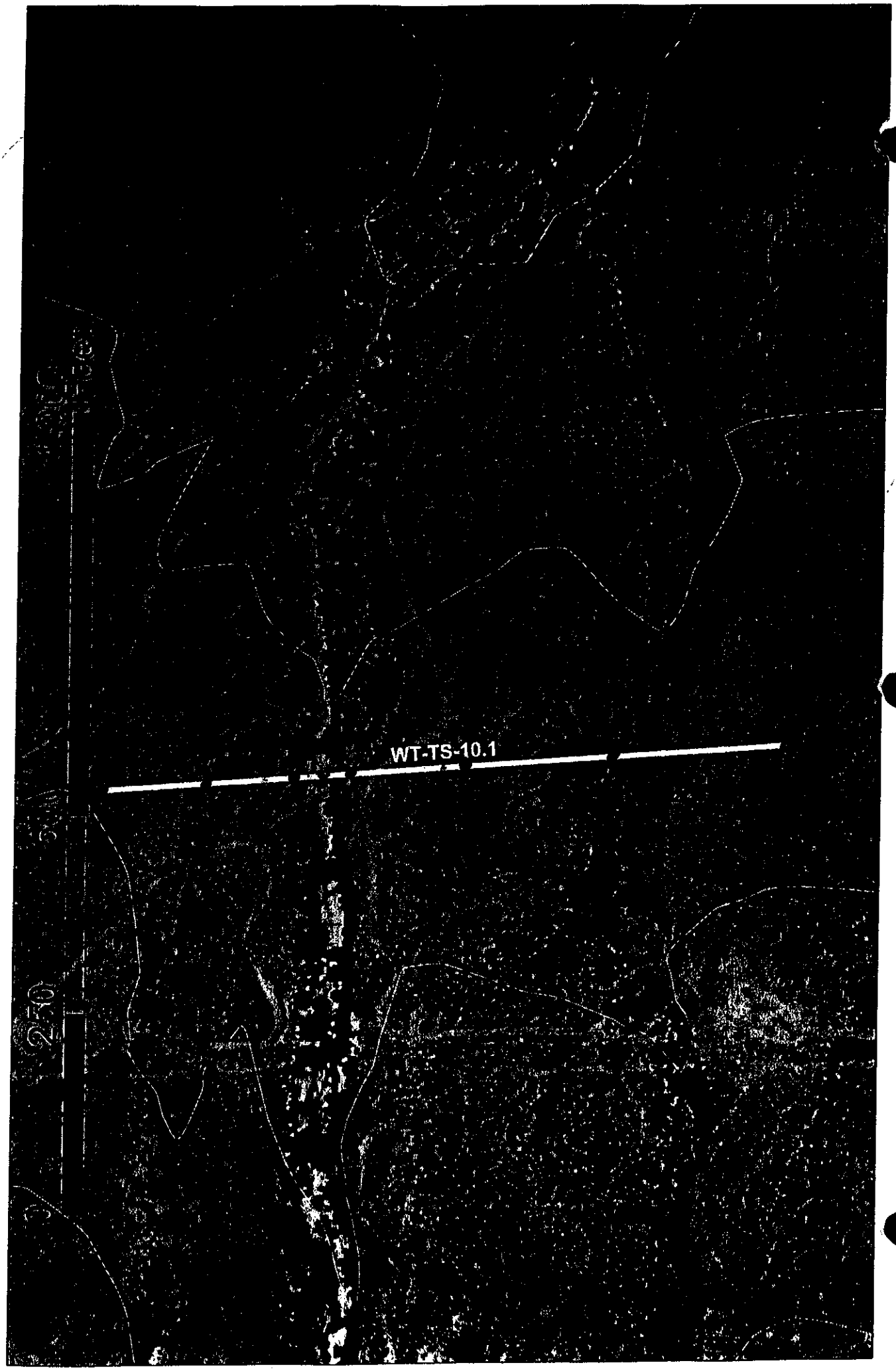
Channel = .035*

Overbank = .060*

* See table 6.11 from FCD manual

Appendix D.3.1

South Region "n" Values

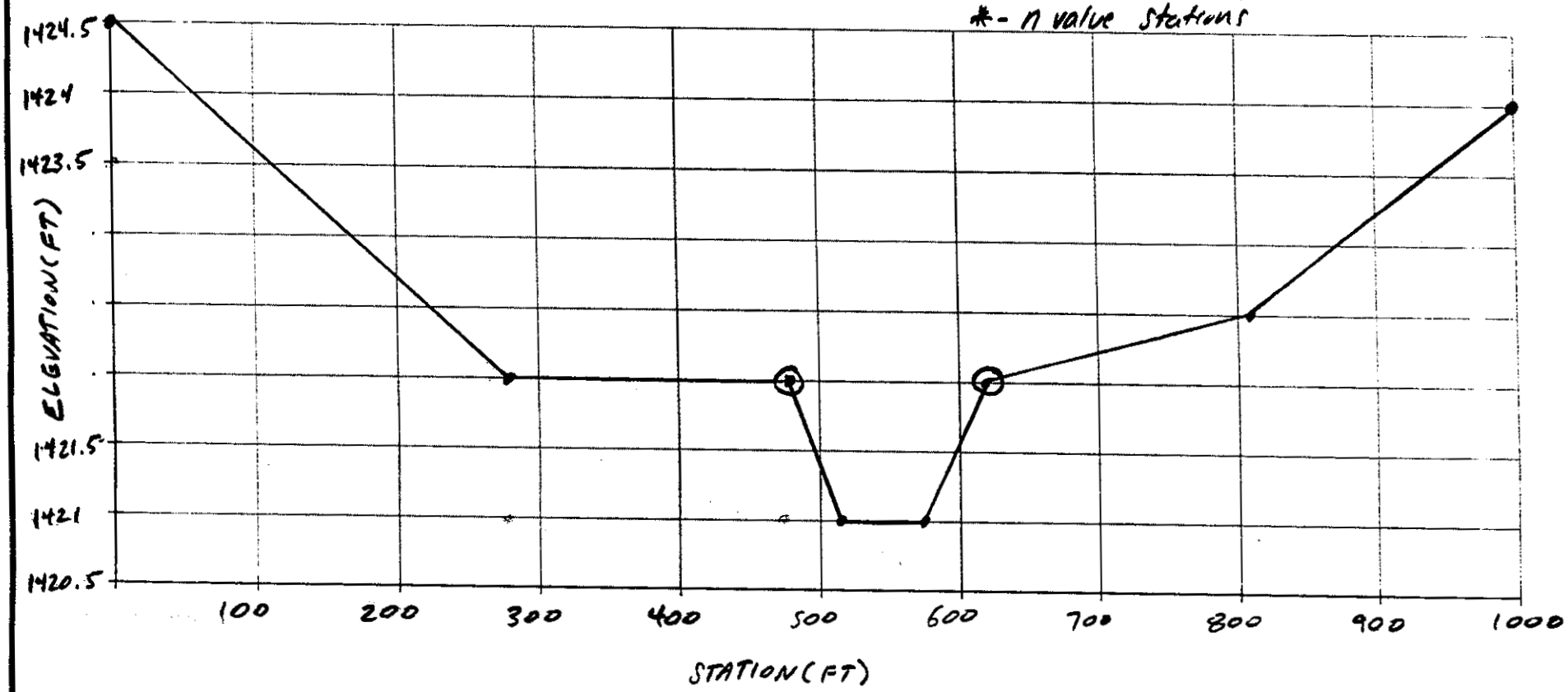

WT-TS-10.1

P:\300\310\310032 ... Section Geometry\PD-TS.dwg

By: JS Date: 2/3/4
Ckd: CJC Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1424.5	
280	1422	
475	1422	*
520	1421	
570	1421	
618	1422	*
803	1422.5	
1036	1424	

*- n value stations



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CHANNEL ROUTING TYPICAL CROSS-SECTION
WT-TS-10.1
Date: 4/20/2004

D.3.2. Cross Section Geometry

Appendix D.3.2

Typical Cross Sections by "n" Value Region

1) Cross Sections Using **Outlet Channel** Region "n" Values

2) Cross Sections Using **North** Region "n" Values

3) Cross Sections Using **Central** Region "n" Values

4) Cross Sections Using **South** Region "n" Values

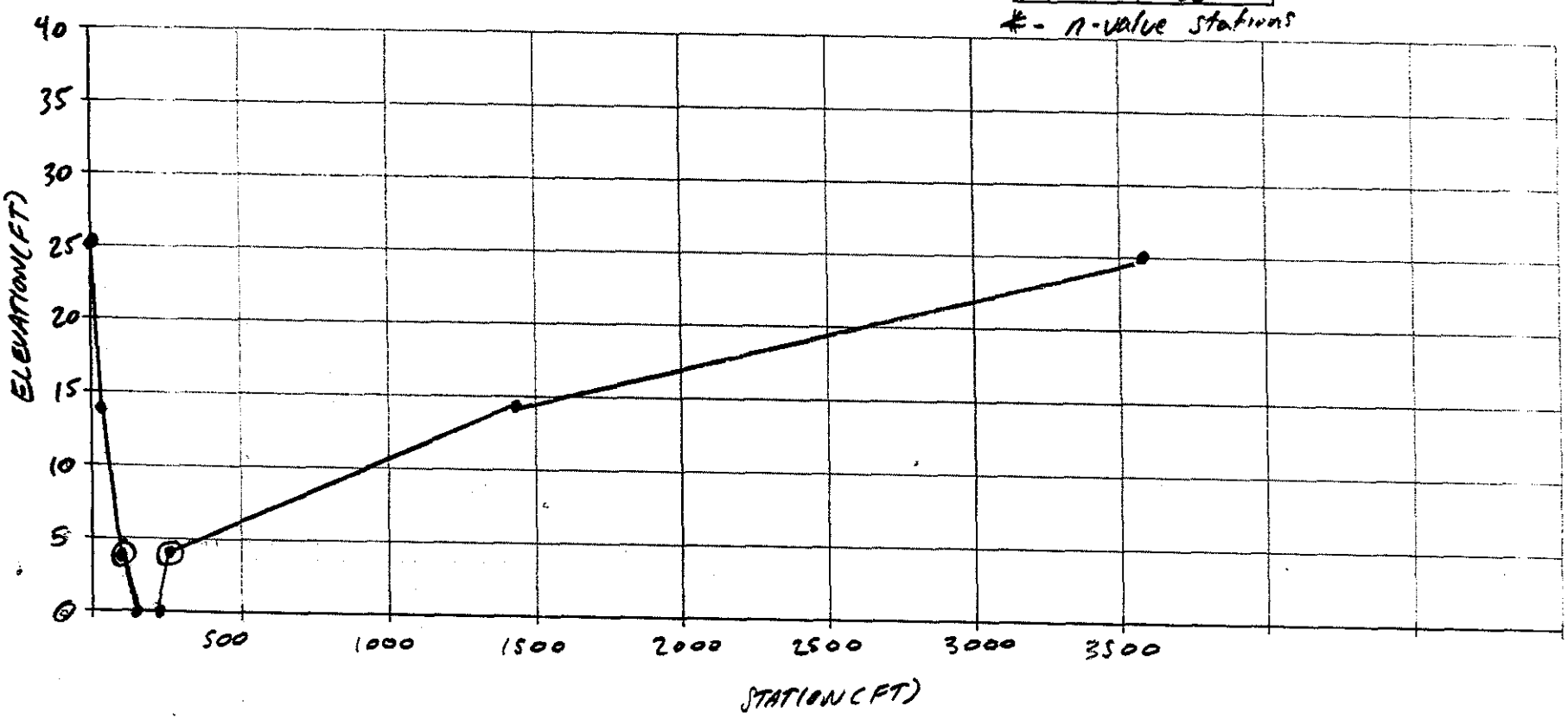
Outlet Channel Typical Sections

P:\300\310\310032 ction Geometry\PD-TS.dwg

By: RAS Date: 2/12/4
Ckd: JS Date: 4/19/4

Station(ft)	Elevation(ft)	
0	25	
46	14	
101	4	*
121	0	
171	0	
181	4	*
1421	14	
3621	25	

*- n-value stations



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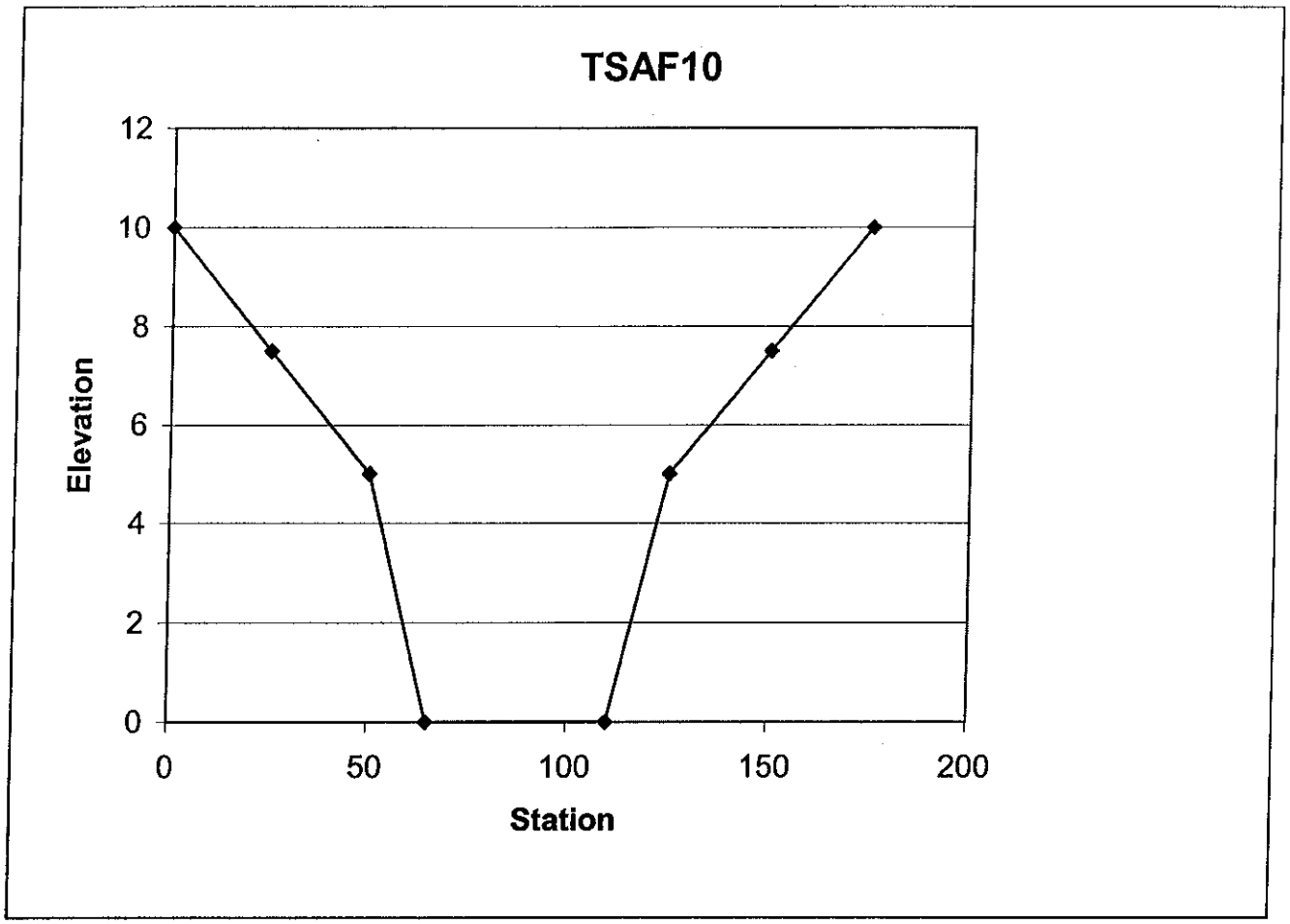
CHANNEL ROUTING TYPICAL CROSS-SECTION
McMicken Dam Outlet Channel
Date: 4/20/2004



Station	Elevation
0	10
25	7.5
50	5
65	0
110	0
125	5
150	7.5
175	10

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SHEET _____ OF _____

BY _____ DATE _____

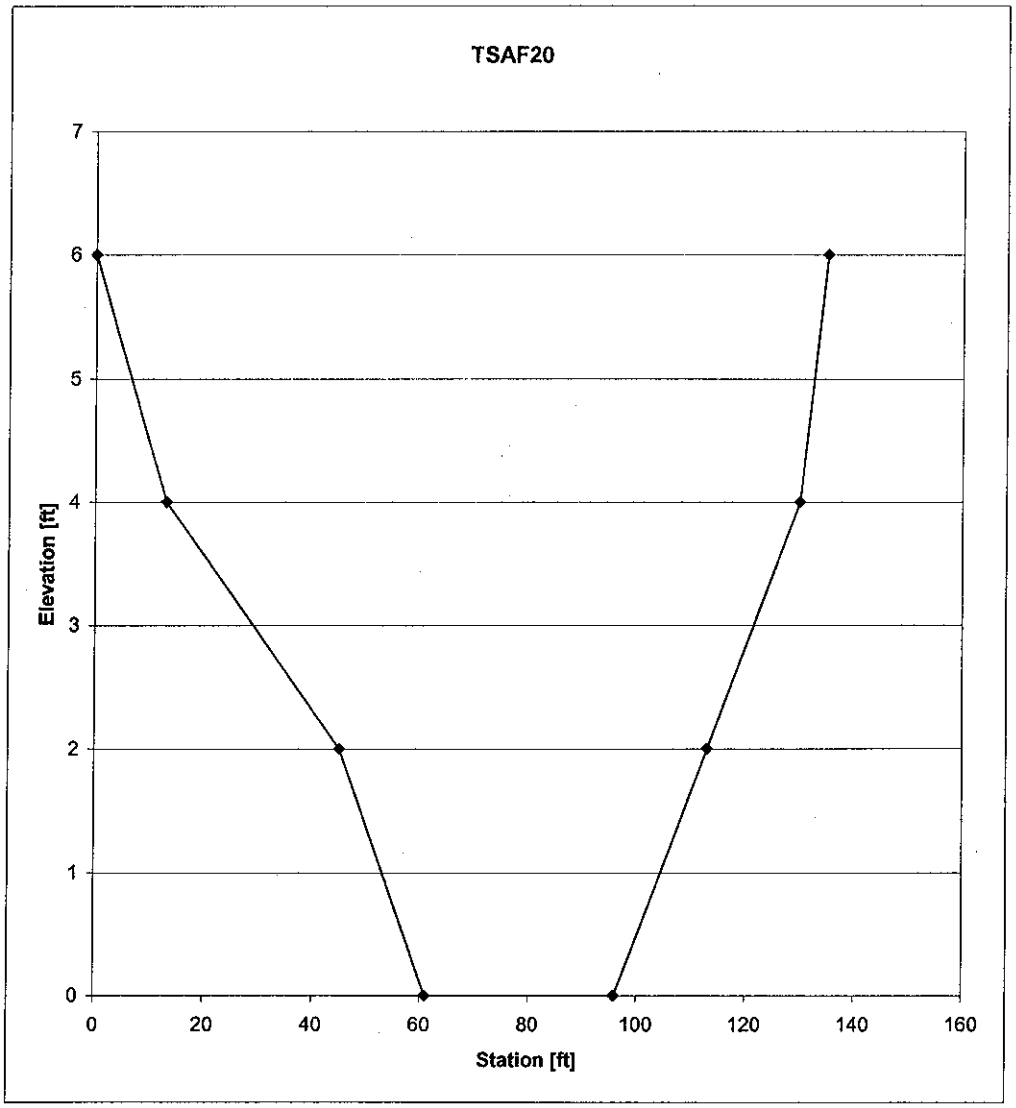
CHECK _____ DATE _____

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

JOB NO. 310.032

Station	Elevation
0	6
13	4
45	2
61	0
96	0
113	2
130	4
135	6



North Region Typical Sections

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SHEET ____ OF ____

BY JS DATE 4/15/4

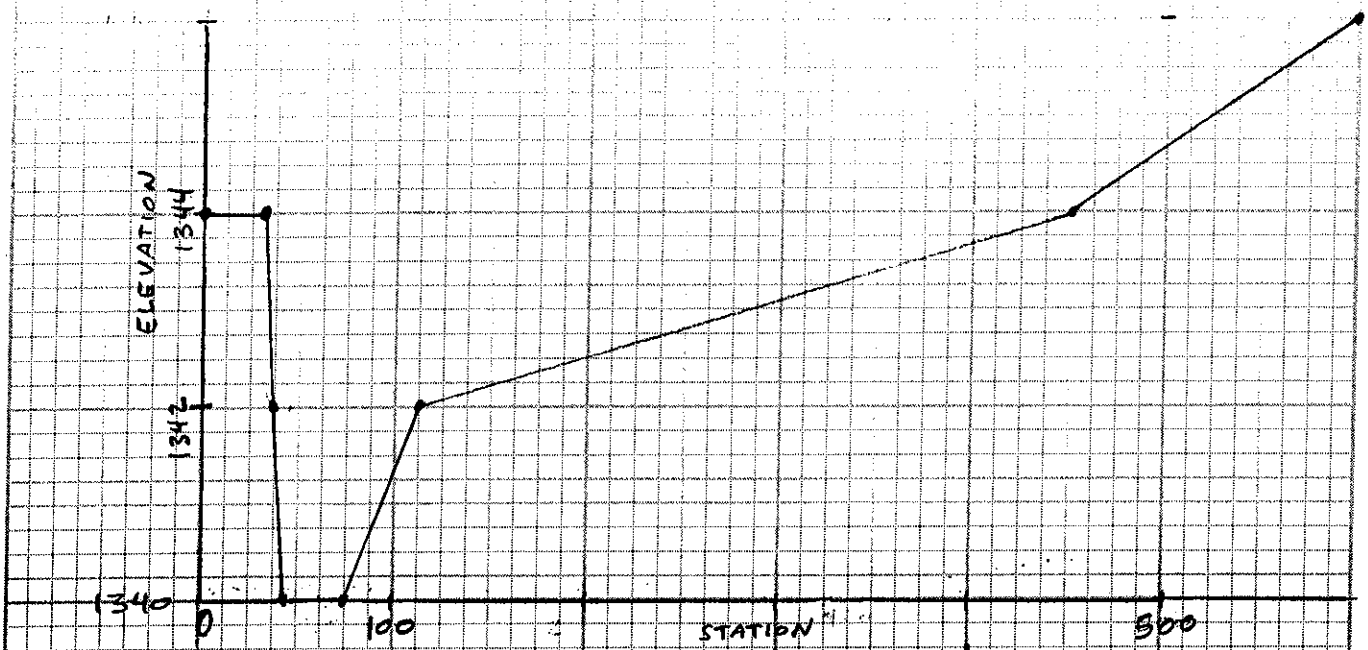
CHECK RAS DATE 4/19/04

CLIENT FCO

JOB NAME Wittmann OOMSU JOB NO. 310032

TSBEAR

Typical Section: Along north side of Beardsley Canal



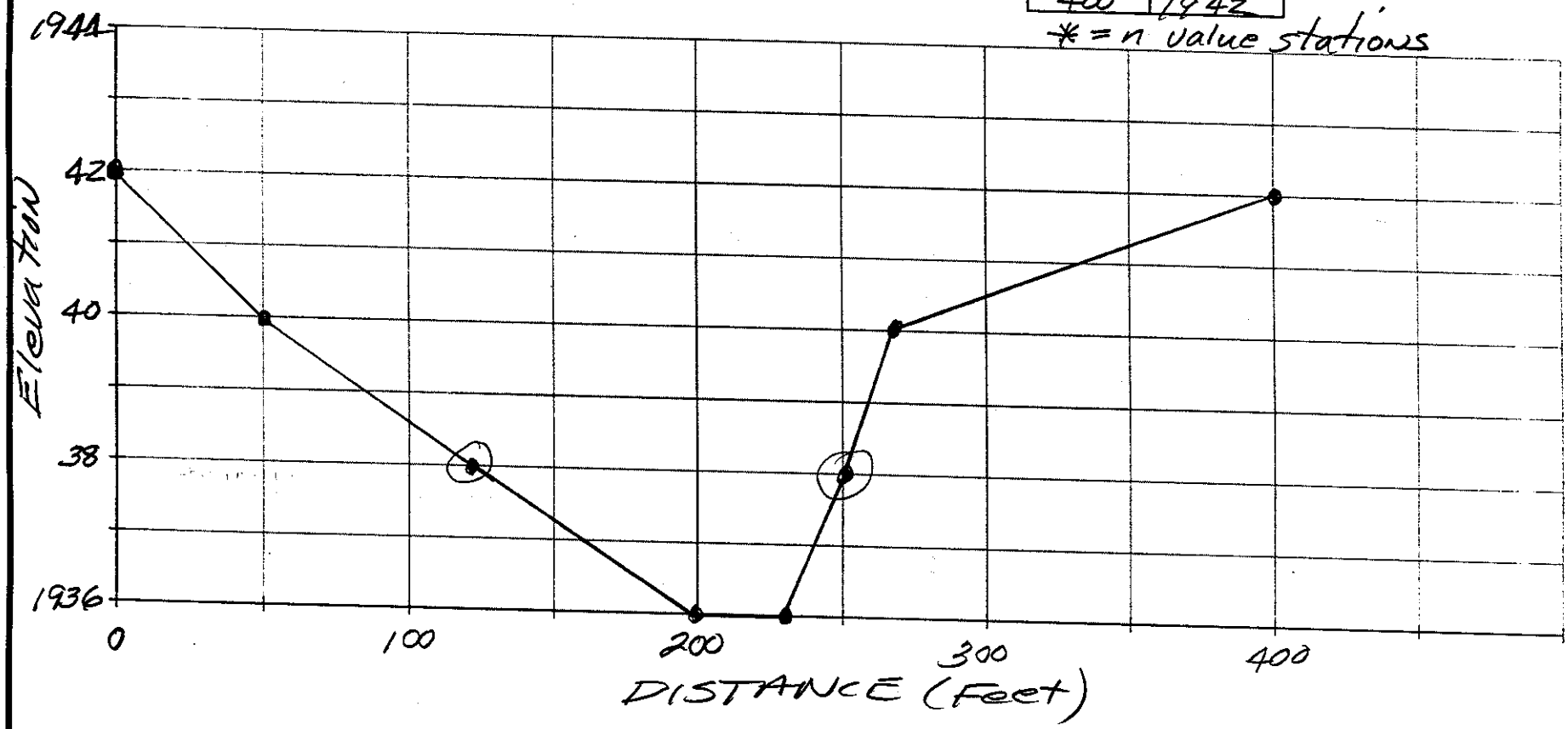
Pt#	STATION	ELEVATION	
1	0	1344	
2	25	1344	
3	30	1342	- n-value station
4	35	1340	
5	60	1340	
6	110	1342	- n-value station
7	460	1344	
8	600	1345	

P:\300\310\310031 ection Geometry\PD-TS.dwg

By: JS Date: 2/3/4
Ckd: CJL Date: 4/20/4

Station(ft)	Elevation(ft)
0	1942
50	1940
125	1938 *
200	1936
230	1936
250	1938 *
260	1940
400	1942

* = n value stations



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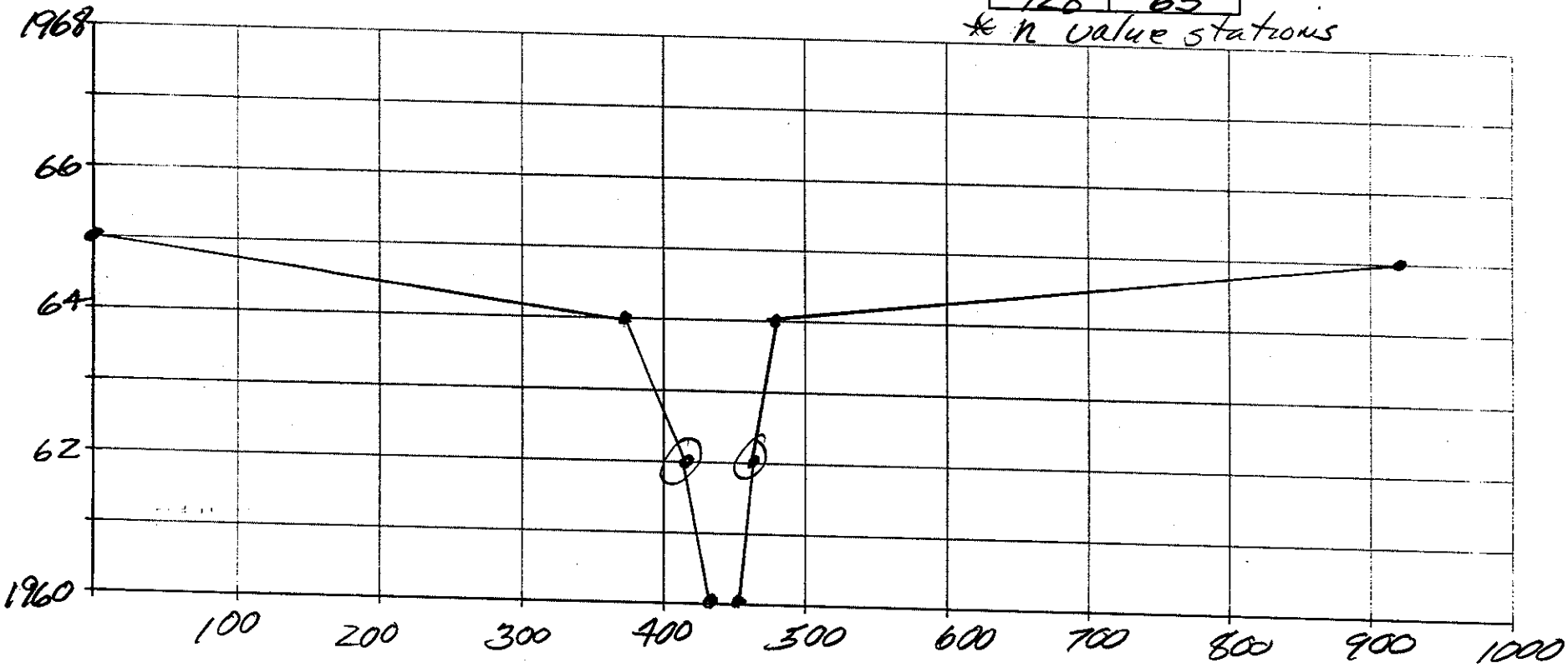
CHANNEL ROUTING TYPICAL CROSS-SECTION
WI-TS-90.1
Date: 4/20/2004

P:\300\310\31003: ection Geometry\PD-TS.dwg

By: JV Date: 2/3/4
Ckd: CJC Date: 2/3/4

Station(ft)	Elevation(ft)
0	1965
386	1964
410	62 *
430	60
450	60
460	62 *
471	64
928	65

* n value stations



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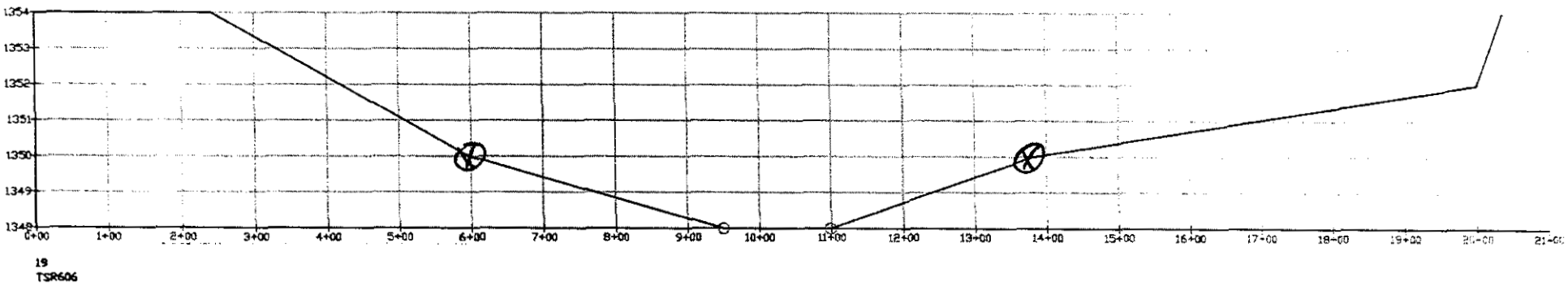
CHANNEL ROUTING TYPICAL CROSS-SECTION
TW-TS-20
Date: 4/20/2004

By : JS Date : 3/17/4
Ckd : CSL Date : 3/18/4

	Station(ft)	Elevation(ft)
	0	1354
	241	1354
n-value station	598	1350
	949	1348
	1098	1348
n-value station	1381	1350
	2002	1352
	2039	1354



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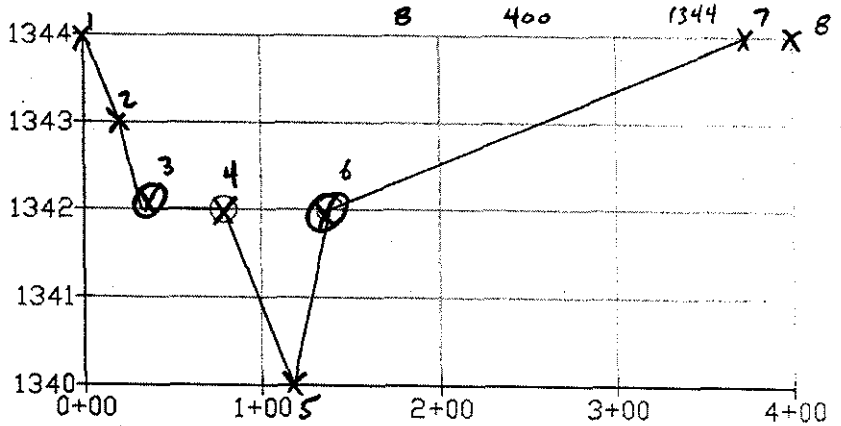
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR606
Date : 3/17/2003

By : JS Date : 3/17/4
Ckd : CTL Date : 3/18/4

Pt ID	Station(ft)	Elevation(ft)	
1	0	1344	
2	20	1343	
3	32	1342	— n-value station
	~~35~~	~~1342~~	
4	79	1342	
5	118	1340	
6	139	1342	— n-value station
7	374	1344	
8	400	1344	



25
TSR621

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CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR621
Date : 3/17/2003

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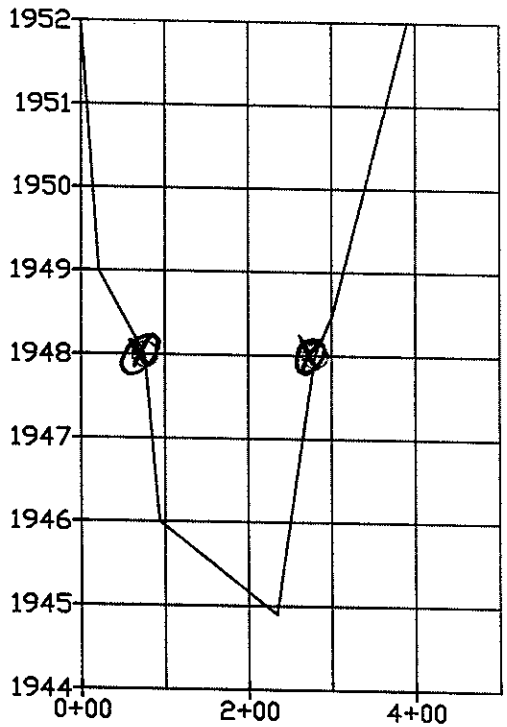
By : _____ Date : _____
Ckd : CSL Date : 2/3/4



20.1

Station [ft]	Elevation [ft]	
0	1952	
21	1949	
75	1948	– n-value station
93	1946	
234	1945	
280	1948	– n-value station
301	1948.5	
391	1952	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-20.1 Date : 9/22/2003 Pg : 3 of 9

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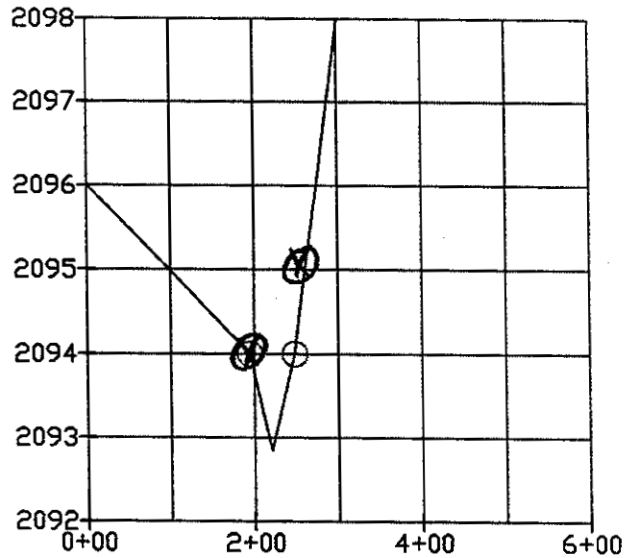
By : _____ Date : _____
Ckd : CSL Date : 2/3/4



10.2

Station [ft]	Elevation [ft]
0	2096
101	2095
195	2094
221	2093
248	2094
260	2095
275	2096
301	2098

- n-value station
- n value station

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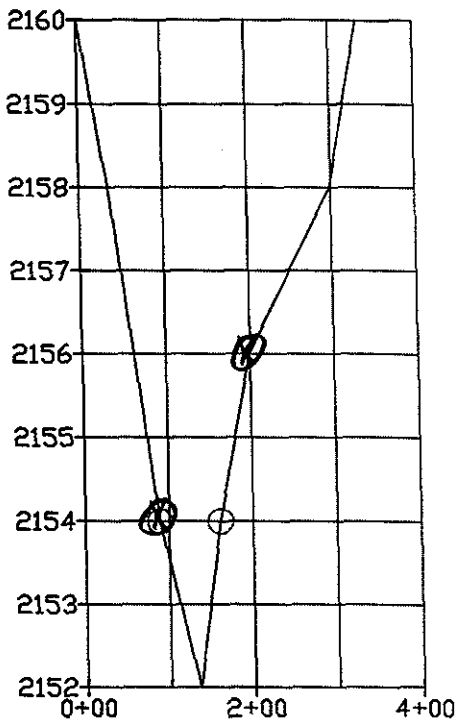
CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-10.2 Date : 9/22/2003 Pg : 2 of 9

P:\300\310\310032\HEC-2\Cross-Section Geometry\IW-TS.dwg

By : _____ Date : _____
Ckd : CZ Date : 2/3/4



10.1

Station [ft]	Elevation [ft]
0	2160
34	2158
89	2154
134	2152
161	2154
198	2156
298	2158
333	2160

- n value station
- n value station

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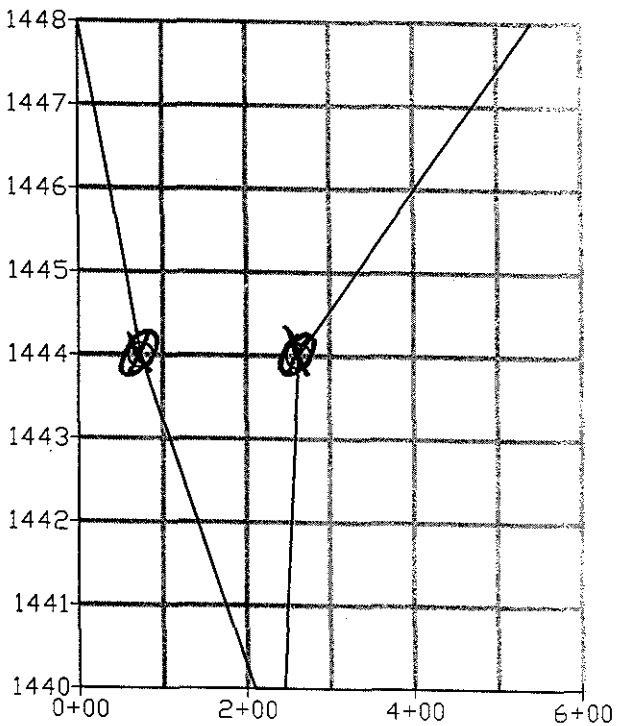
CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-10.1 Date : 9/22/2003 Pg : 1 of 9

P:\300\310\310032 \HEC\X-Section Geometry\PD-TS.dwg

By : _____ Date : _____
Ckd : CSL Date : 2/3/4



40.2

Station [ft]	Elevation [ft]	
0	1448	
38	1446	
74	1444	- n-value station
209	1440	
245	1440	
263	1444	- n-value station
401	1446	
541	1448	

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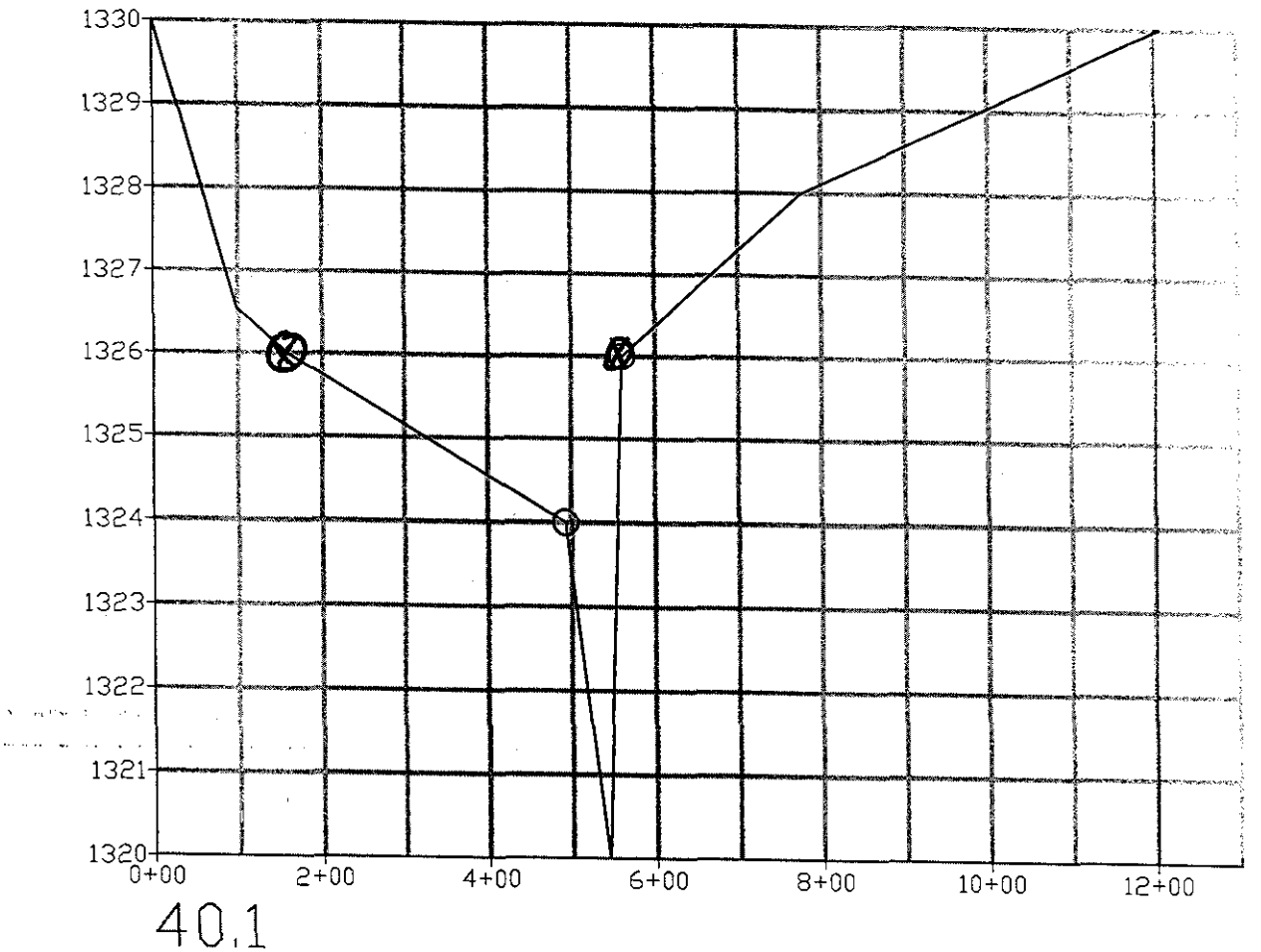
CHANNEL ROUTING TYPICAL CROSS-SECTION
PEDAL FORD WASH
Section : PD-TS-40.2 Date : 9/22/2003 Pg : 5 of 5

P:\300\310\310032 \HEC\X-Section Geometry\PD-TS.dwg

By : _____ Date : _____
Ckd : CSC Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1330	
86	1326.5	
158	1326	- n-value Station
492	1324	
543	1320	
560	1326	- n-value Station
776	1328	
1208	1330	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
PEDAL FORD WASH
Section : PD-TS-40.1 Date : 9/22/2003 Pg : 4 of 5

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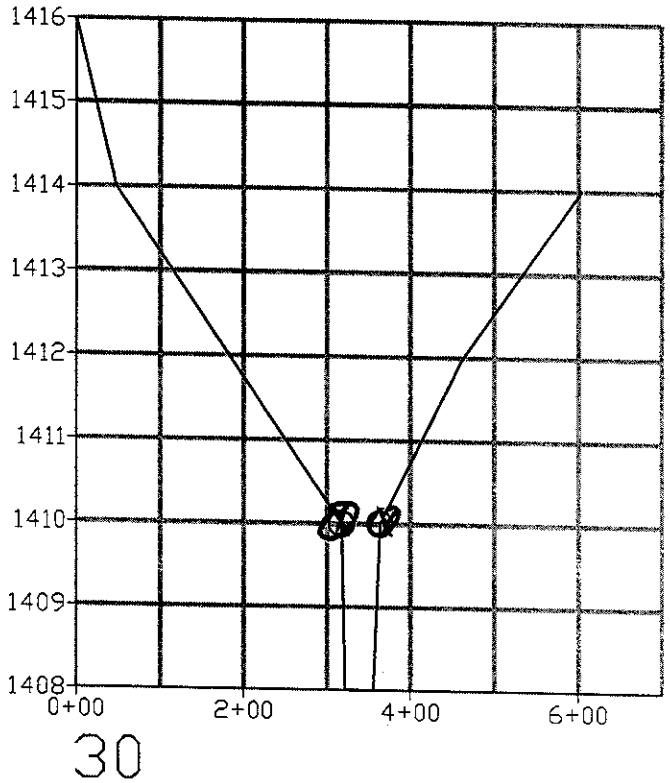
By : _____ Date : _____
Ckd : CSL Date : 2/3/4



Station [ft]	Elevation [ft]
0	1416
47	1414
318	1410
322	1408
356	1408
364	1410
463	1412
604	1414

- n value station
- n value station

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CHANNEL ROUTING TYPICAL CROSS-SECTION
PEDAL FORD WASH
Section : PD-TS-30 Date : 9/22/2003 Pg : 3 of 5

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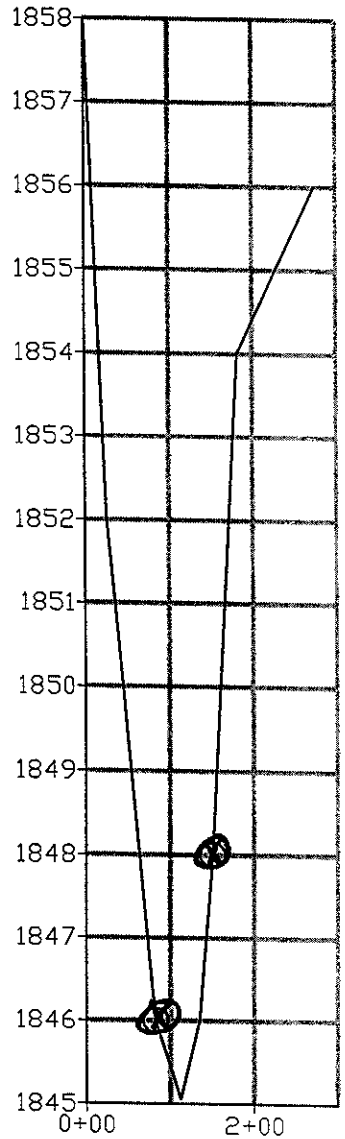

20

Station [ft]	Elevation [ft]	
0	1858	
26	1852	
82	1846	— n-value station
114	1845	
135	1846	
151	1848	— n-value station
181	1854	
274	1856	

By : _____ Date : _____
Ckd : [illegible] Date : 2/3/04

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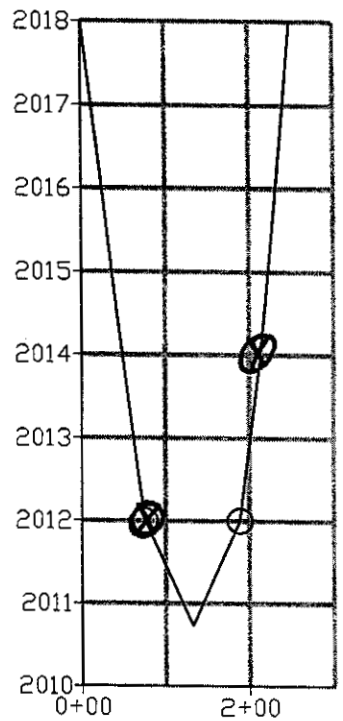
PEDAL FORD WASH
Section : PD-TS-20 Date : 9/22/2003 Pg : 2 of 5

P: \300\310\310032 \HEC\X-Section Geometry\PD-TS.dwg

By : _____ Date : _____
Ckd : CJL Date : 2/3/04



10

Station [ft]	Elevation [ft]	
0	2018	
48	2014	
75	2012	- n-value station
132	2010.5	
189	2012	
214	2014	- n-value station
232	2016	
249	2018	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
PEDAL FORD WASH
Section : PD-TS-10 Date : 9/22/2003 Pg : 1 of 5

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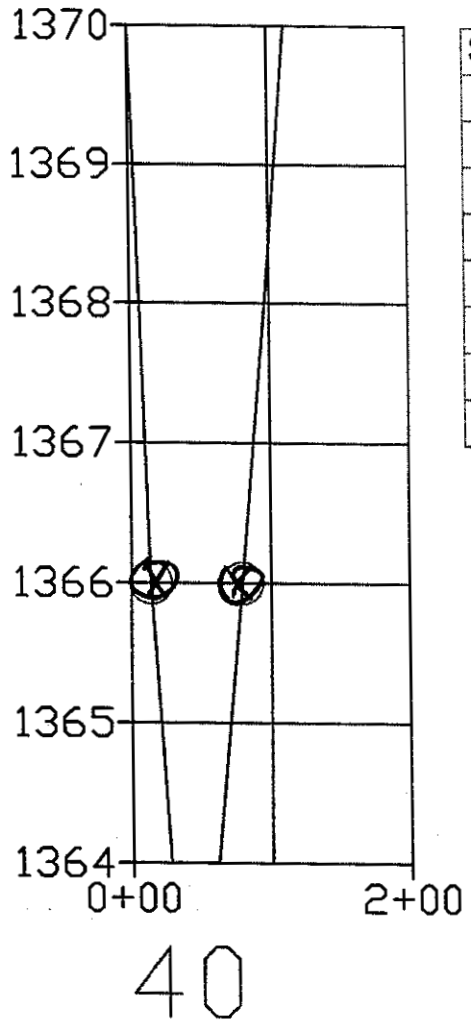
By : _____ Date : _____
Ckd : CSL Date : 2/3/4



Station [ft]	Elevation [ft]	
0	1370	
7	1368	
14	1366	– n value station
27	1364	
61	1364	
79	1366	– n-value station
97	1368	
113	1370	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
PICACHO WASH
Section : PI-TS-40 Date : 9/22/2003 Pg : 5 of 5

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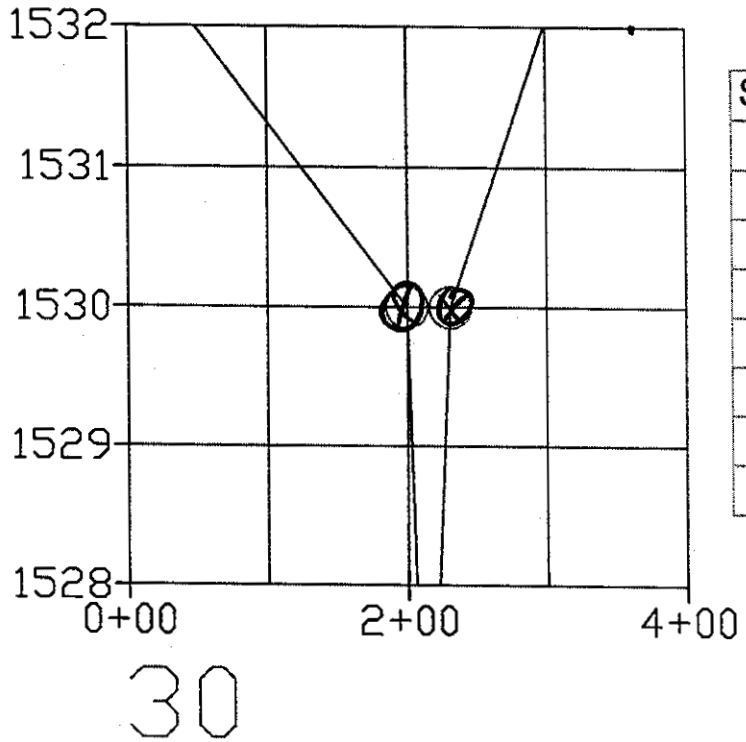
By : _____ Date : _____
Ckd : CJL Date : 2/3/4



Station [ft]	Elevation [ft]	
0	1532	
49	1532	
199	1530	- n-value station
206	1528	
222	1528	
231	1530	- n-value station
299	1532	
375	1532	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
PICACHO WASH
Section : PI-TS-30 Date : 9/22/2003 Pg : 4 of 5

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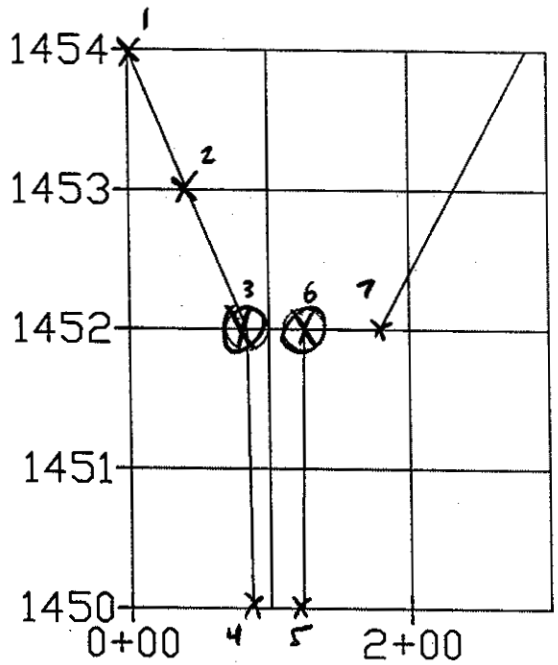
By : _____ Date : _____
Ckd : CX Date : 2/3/04



Pt ID	Station [ft]	Elevation [ft]	
1	0	1454	
3	84	1452	- n-value station
4	87	1450	
5	123	1450	
6	125	1452	- n-value station
7	156	1452	
	~~179~~	~~1452.5~~	
8	285	1454	
2	50	1453	

20

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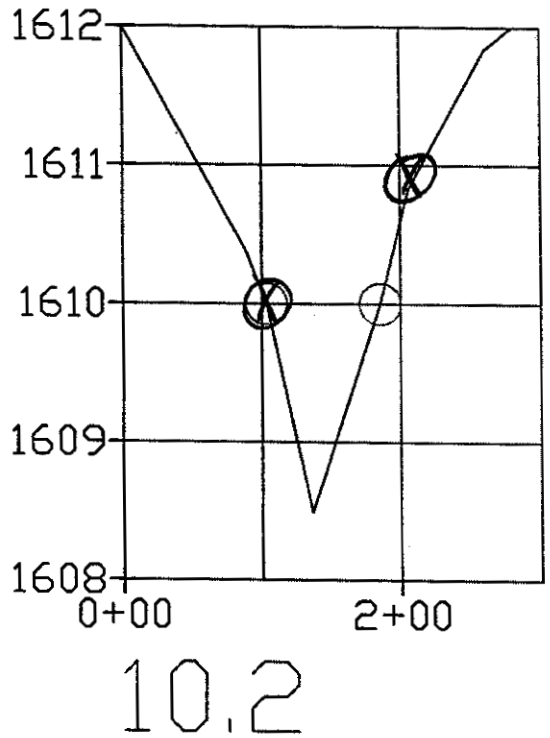
CHANNEL ROUTING TYPICAL CROSS-SECTION
PICACHO WASH
Section : PI-TS-20 Date : 9/22/2003 Pg : 3 of 5

P:\300\310\310032 \HEC\X-Section Geometry\PI-TS.dwg

By : _____ Date : _____
Ckd : CJL Date : 2/3/4



Station [ft]	Elevation [ft]	
0	1612	
89	1610.5	
103	1610	- n-value station
136	1608.5	
185	1610	
206	1611	- n-value station
261	1611.8	
280	1612	

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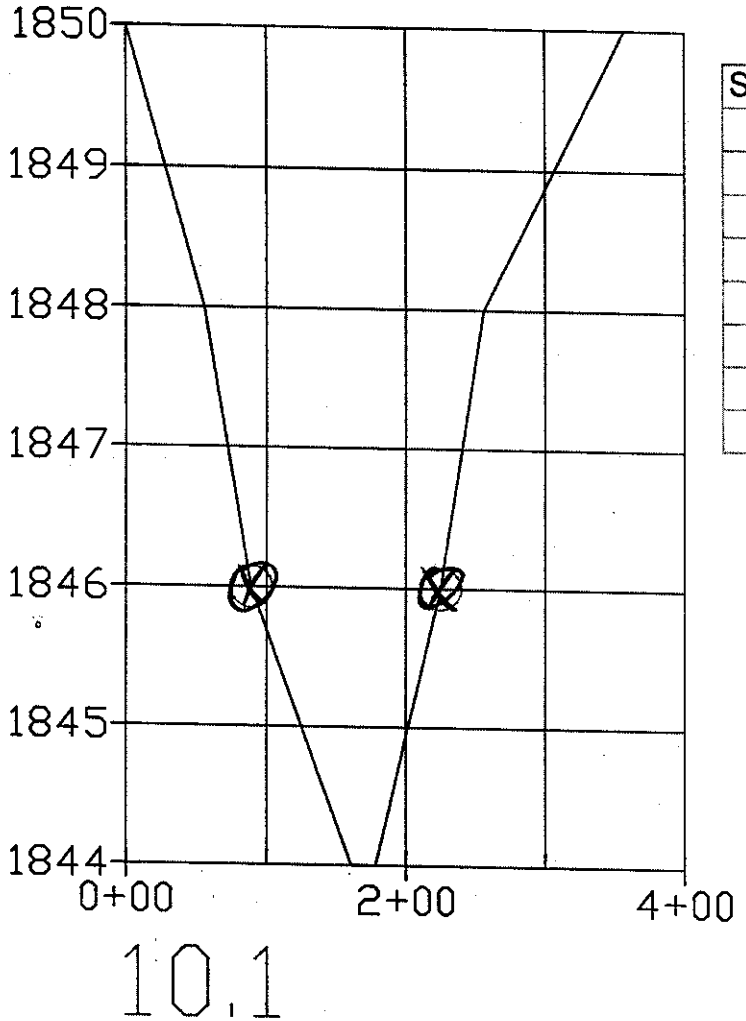
CHANNEL ROUTING TYPICAL CROSS-SECTION
PICACHO WASH
Section : PI-TS-10.2 Date : 9/22/2003 Pg : 2 of 5

By : _____ Date : _____
Ckd : CSC Date : 2/3/4



Station [ft]	Elevation [ft]
0	1850
56	1848
89	1846
161	1844
178	1844
225	1846
256	1848
357	1850

- n-value station
- n-value station

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CHANNEL ROUTING TYPICAL CROSS-SECTION
PICACHO WASH
Section : PI-TS-10.1 Date : 9/22/2003 Pg : 1 of 5

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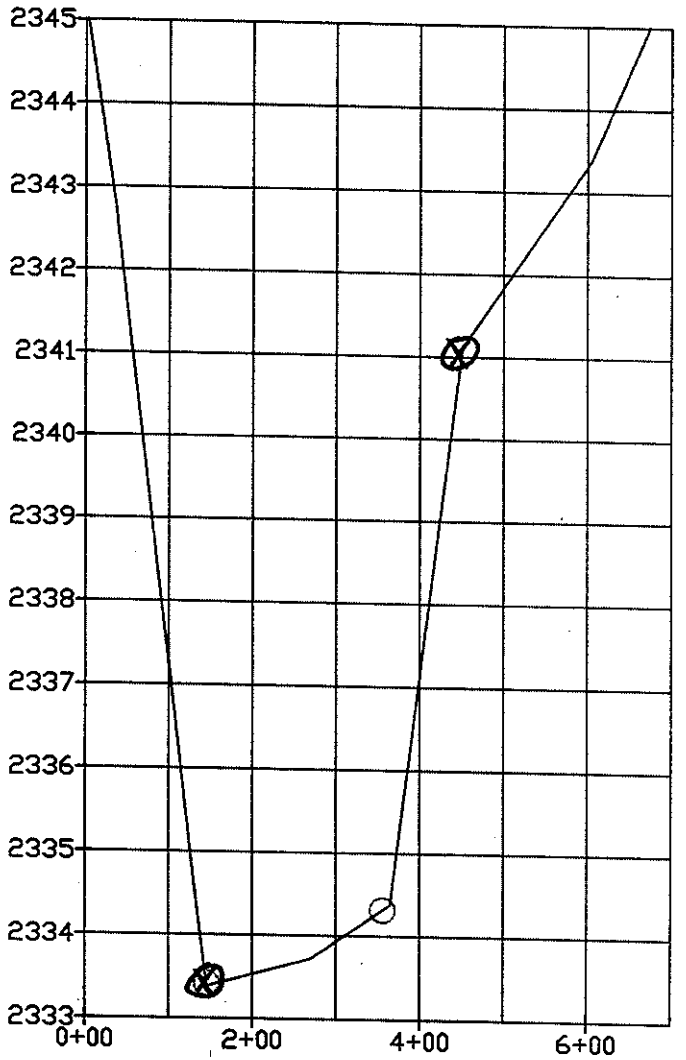
By : _____ Date : _____
Ckd : CSL Date : 2/3/04



10

Station [ft]	Elevation [ft]	
0	2345	
36	2343	
145	2333.5	- n-value station
269	2334	
364	2334.5	
451	2341	- n-value station
605	2343.5	
684	2345	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
TRILBY WASH
Section : TW-TS-10 Date : 9/22/2003 Pg : 1 of 5

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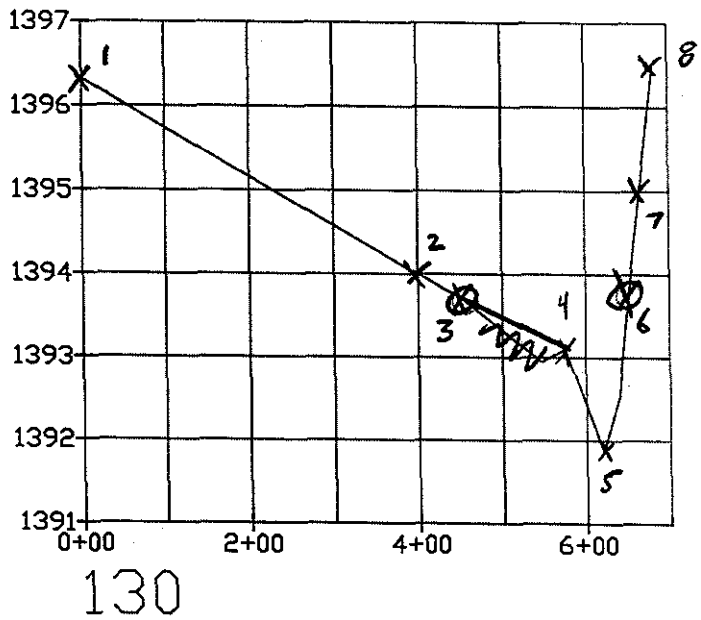
By : _____ Date : _____
Ckd : CSL Date : 2/3/04



Pt ID	Station [ft]	Elevation [ft]	
1	0	1396.5	
8 3	456	1393.5	- n-value station
	~~547~~	~~1393~~	
4	575	1393	
5	620	1392	
	~~639~~	~~1392.5~~	
	~~652~~	~~1394~~	
8	682	1396.5	
2	400	1394	
6	650	1394	- n-value station
7	660	1395	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-130 Date : 9/22/2003 Pg : 13 of 13
↳ Typical Railroad Diversion

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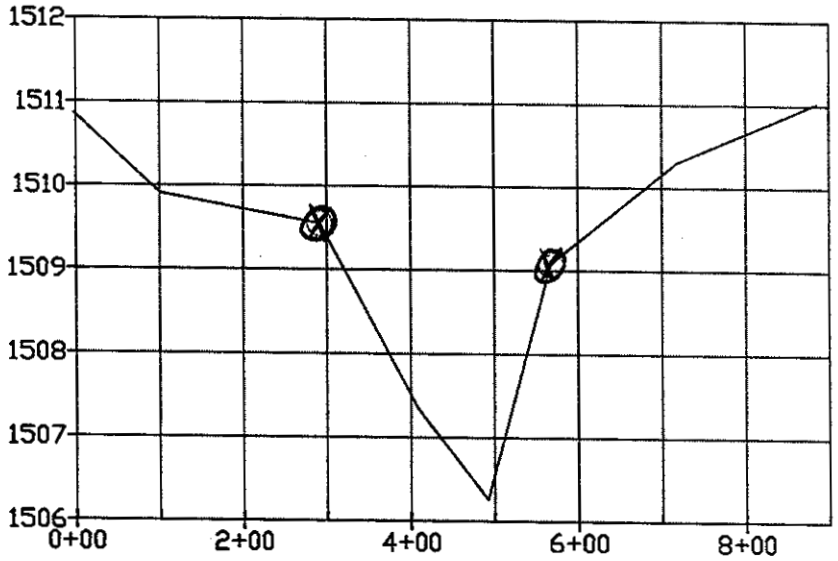
By : _____ Date : _____
Ckd : CJL Date : 2/3/04



120

Station [ft]	Elevation [ft]
0	1511
100	1510
292	1509.5
409	1507.5
492	1506
567	1509
718	1510.5
886	1511

- n-value station
- n-value station

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-120 Date : 9/22/2003 Pg : 12 of 13

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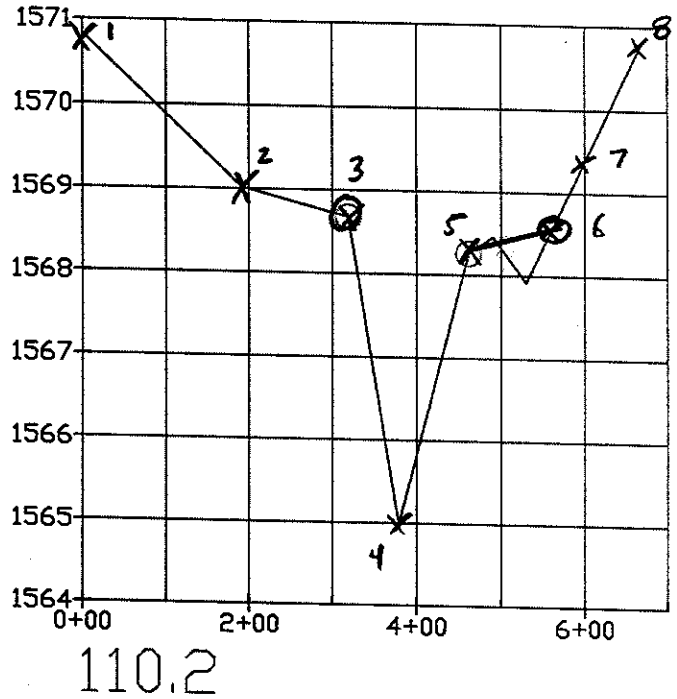
By : _____ Date : _____
Ckd : CSL Date : 2/3/04



Pt ID	Station [ft]	Elevation [ft]	
1	0	1571	
2	190	1569	
3	319	1568.5	- n-value station
4	379	1565	
	~~402~~	~~1568.5~~	
	~~491~~	~~1568.5~~	
	~~530~~	~~1568~~	
8	667	1571	
5	460	1568.5	
6	560	1568.5	- n-value station
7	600	1569.5	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-110.2 Date : 9/22/2003 Pg : 10 of 15

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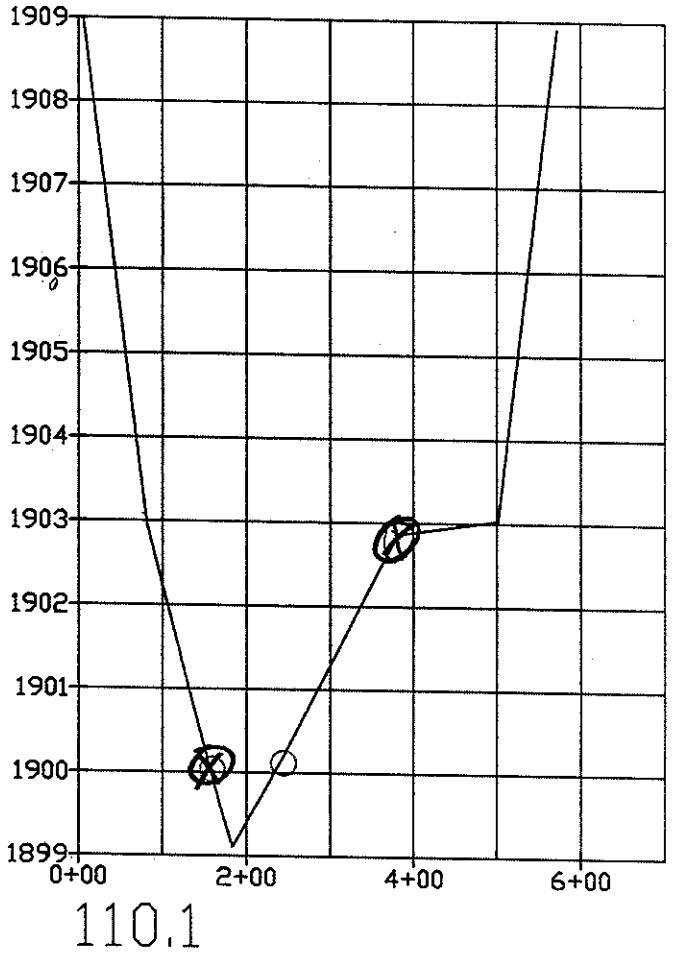

Station [ft]	Elevation [ft]	
0	1909	
82	1903	
155	1900	-n-value station
186	1899	
241	1900	
380	1903	-n-value station
502	1903	
570	1909	

By : _____ Date : _____
Ckd : CJR Date : 2/3/04

(Cross ID)

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-110.1 Date : 9/22/2003 Pg : 11 of 13

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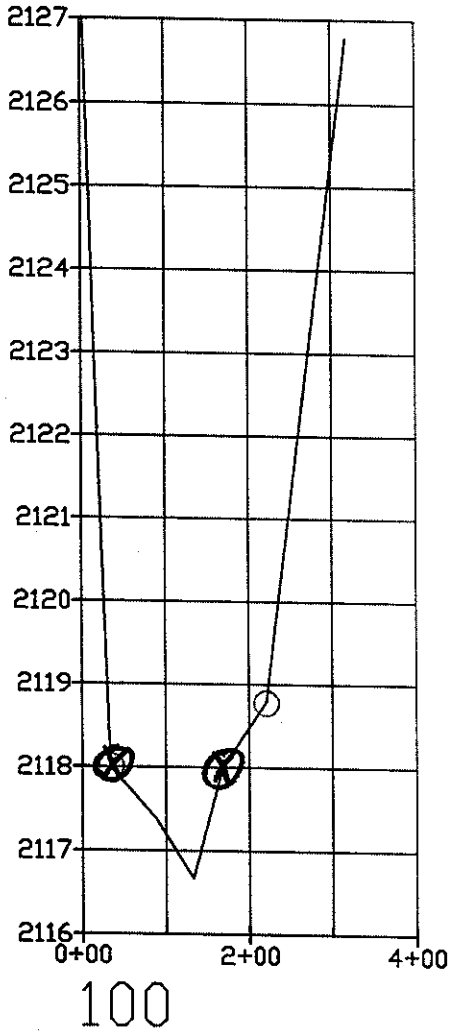
By : _____ Date : _____
Ckd : CJL Date : 2/3/04



Station [ft]	Elevation [ft]	
0	2127	
16	2123	
34	2118	– n-value station
89	2117.5	
132	2116.5	
168	2118	– n-value station
221	2119	
326	2127	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-100 Date : 9/22/2003 Pg : 9 of 13

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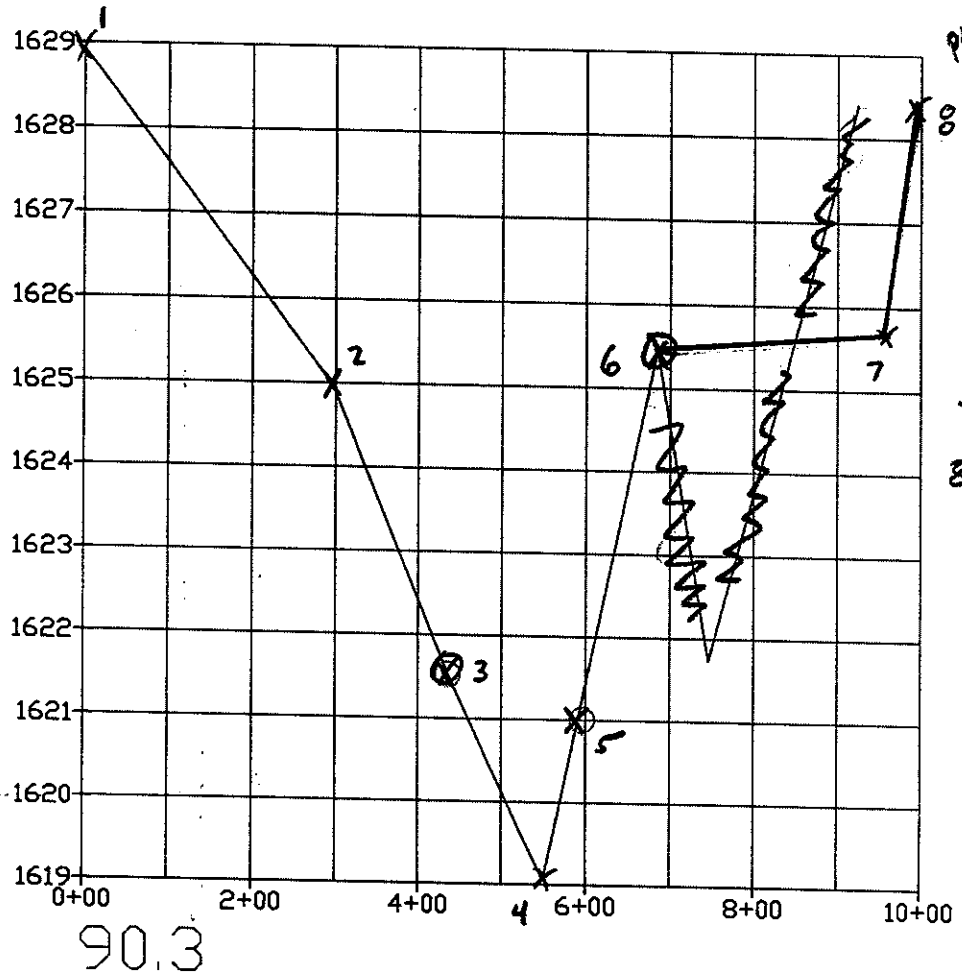
By : _____ Date : _____
Ckd : CTL Date : 2/3/04



Pt ID	Station [ft]	Elevation [ft]	
1	0	1629	
2	294	1625	
3	436	1621.5	- n-value station
4	564	1619	
5	596	1621	
6	685	1625.5	- n-value station
	~~740~~	~~1622~~	
	~~924~~	~~1628.5~~	
7	950	1625.5	
8	1000	1628.5	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-90.3 Date : 9/22/2003 Pg : 8 of 13

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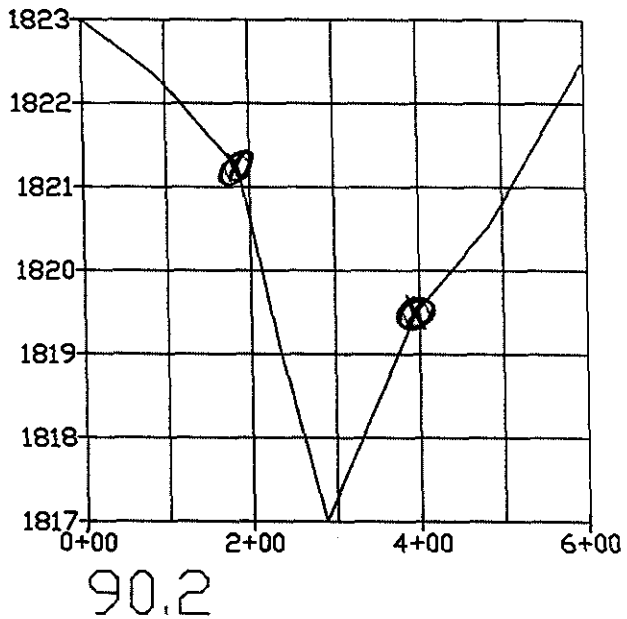
By : _____ Date : _____
Ckd : CZ Date : 2/3/04



Station [ft]	Elevation [ft]
0	1823
89	1822.5
186	1821
233	1819
287	1817
396	1819.5
484	1820.5
597	1822.5

- n-value station
- n-value station

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-90.2 Date : 9/22/2003 Pg : 7 of 13

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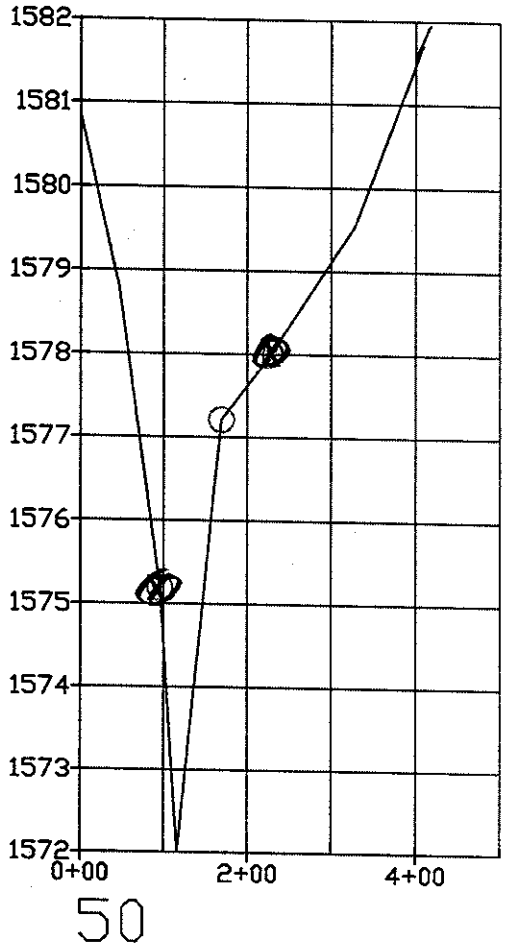
By : _____ Date : _____
Ckd : CSL Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1581	
46	1579	
95	1575	-n-value station
115	1572	
169	1577	
222	1578	-n-value station
328	1579.5	
409	1582	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-50 Date : 9/22/2003 Pg : 5 of 13

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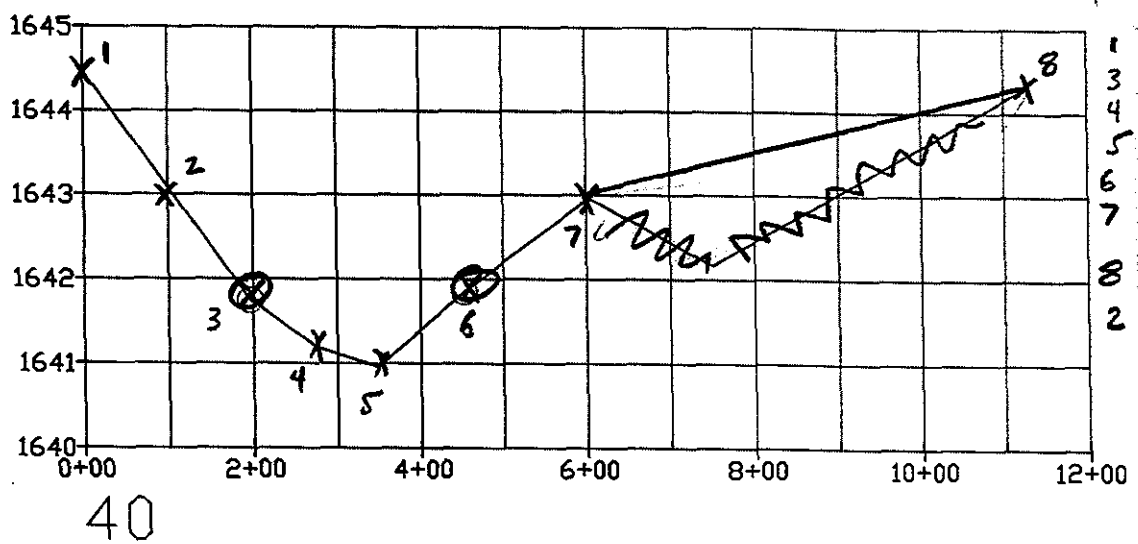
By : _____ Date : _____
Ckd : CJR Date : 2/3/4



pt 10

	Station [ft]	Elevation [ft]	
1	0	1644.5	
3	197	1642	— n-value station
4	277	1641.2	
5	349	1641	
6	452	1642	— n-value station
7	594	1643	
	~~750~~	~~1642~~	
8	1131	1644.5	
2	100	1643	

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CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-40 Date : 9/22/2003 Pg : 4 of 13

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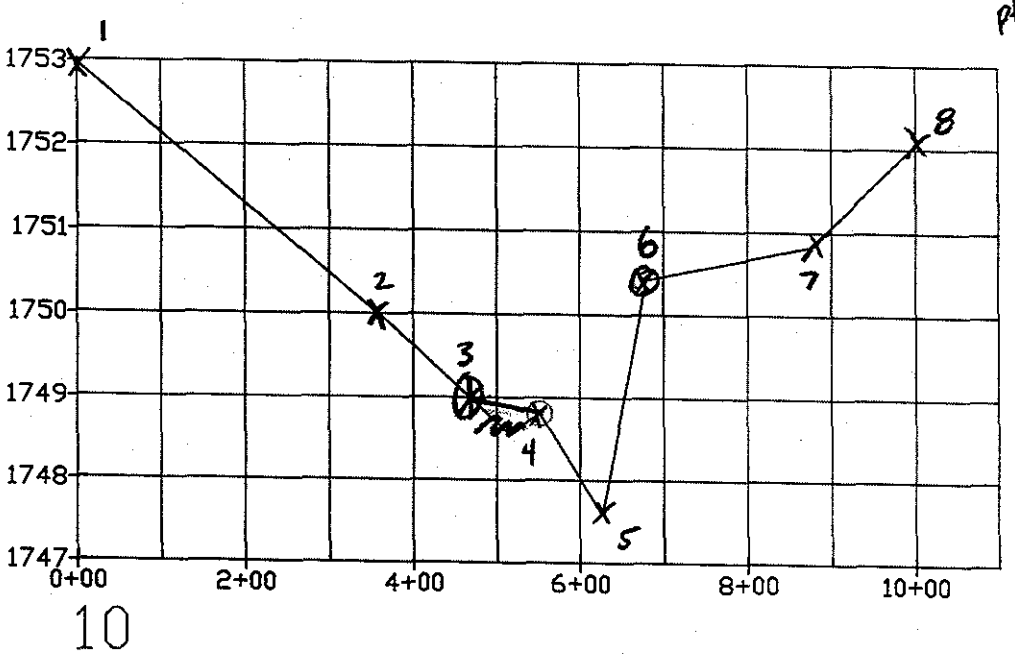
By : _____ Date : _____
Ckd : CJL Date : 2/3/04



Pt ID	Station [ft]	Elevation [ft]	
1	0	1753	
	~~300~~	~~1750~~	
	~~517~~	~~1748.5~~	
4	552	1749	
5	627	1747.5	
6	680	1750.5	- n-value station
7	876	1751	
8	1005	1752	
2	360	1750	
3	460	1749	- n-value station

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CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-10 Date : 9/22/2003 Pg : 1 of 13

Central Region
Typical Sections

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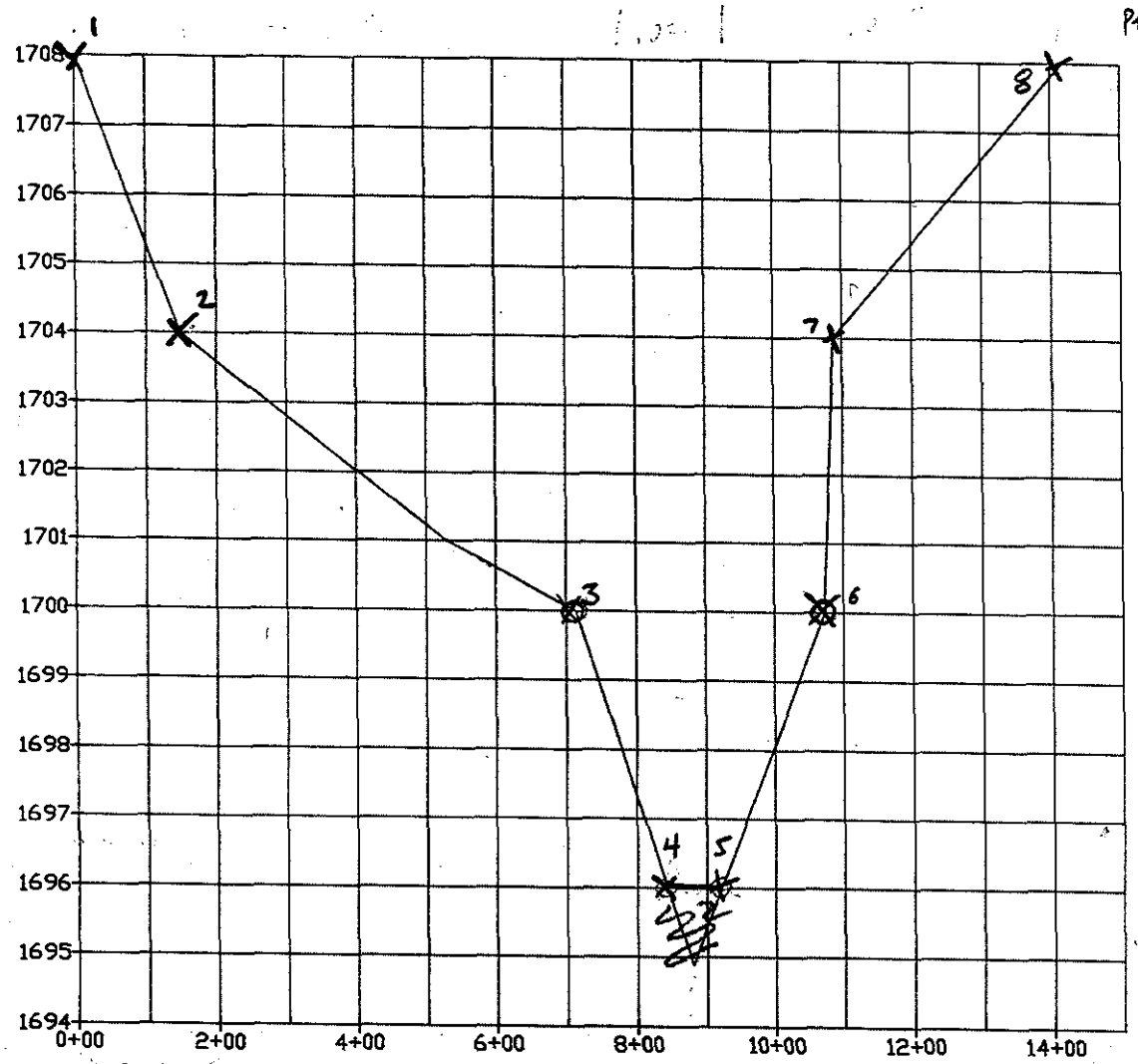
By : _____ Date : _____
Ckd : CSL Date : 2/3/4



40.1

Pt#

	Station [ft]	Elevation [ft]	
1	0	1708	
2	147	1704	
	~~575~~	~~1701~~	
3	714	1700	(n-value station)
	~~880~~	~~1695~~	
6	1073	1700	(n-value station)
7	1087	1704	
8	1417	1708	
4	840	1696	
5	930	1696	

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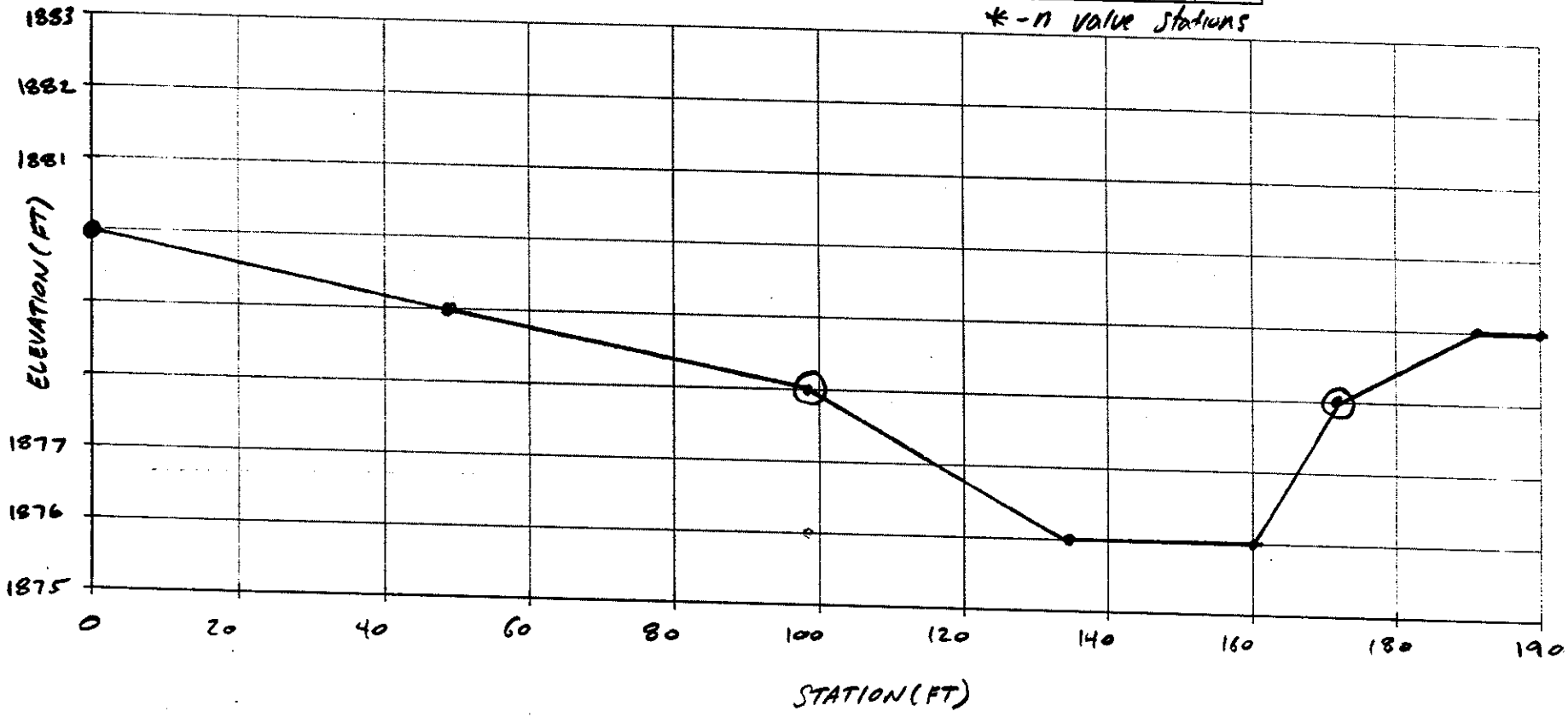
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-40.1 Date : 9/22/2003 Pg : 7 of 9

By: JS Date: 2/3/4
Ckd: CJL Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1880	
50	1879	
96	1878	*
135	1876	
160	1876	
177	1878	*
190	1879	
206	1880	

*-n value stations



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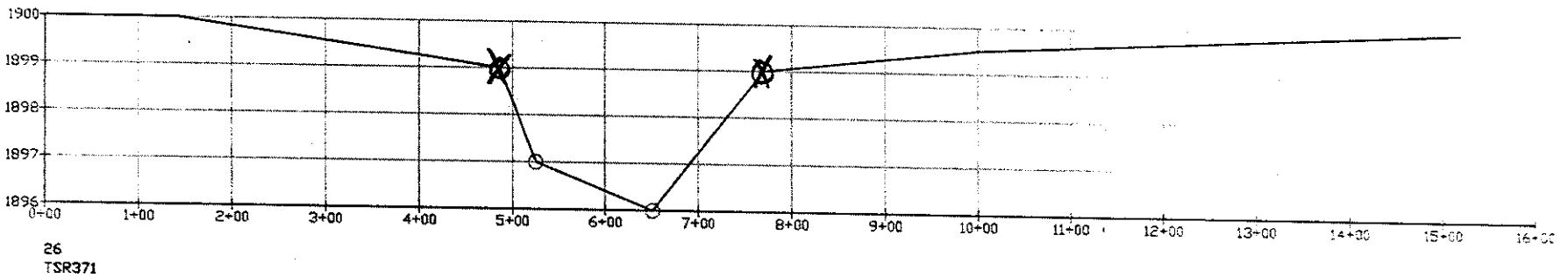
CHANNEL ROUTING TYPICAL CROSS-SECTION
IW-TS-30.1
Date: 4/20/2004

By : JS Date : 3/17/4
Ckd : CR Date : 3/18/4

	Station(ft)	Elevation(ft)
	0	1900
	142	1900
n-value station —	486	1899
	525	1897
	651	1896
n-value station —	770	1899
	1000	1899.5
	1518	1900



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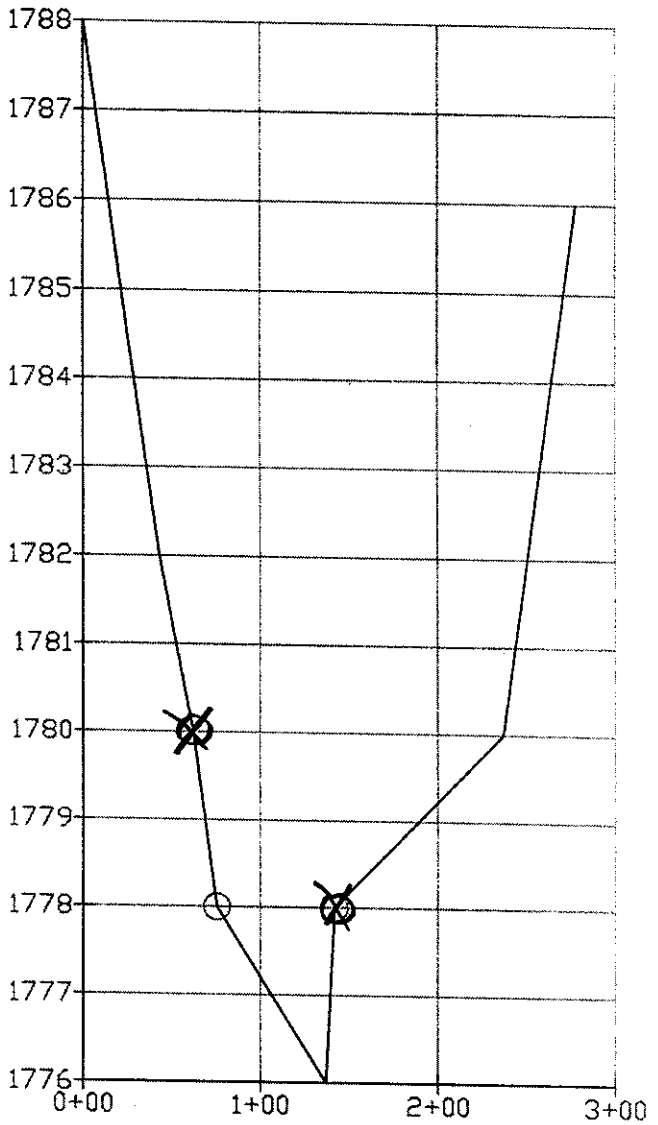
CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR371
Date : 3/17/2003

By : JJ Date : 3/17/19
Ckd : CJC Date : 3/18/19



27
TSR375

Station(ft)	Elevation(ft)	
0	1788	
43	1782	
62	1780	– n-value station
75	1778	
137	1776	
142	1778	– n-value station
237	1780	
278	1786	

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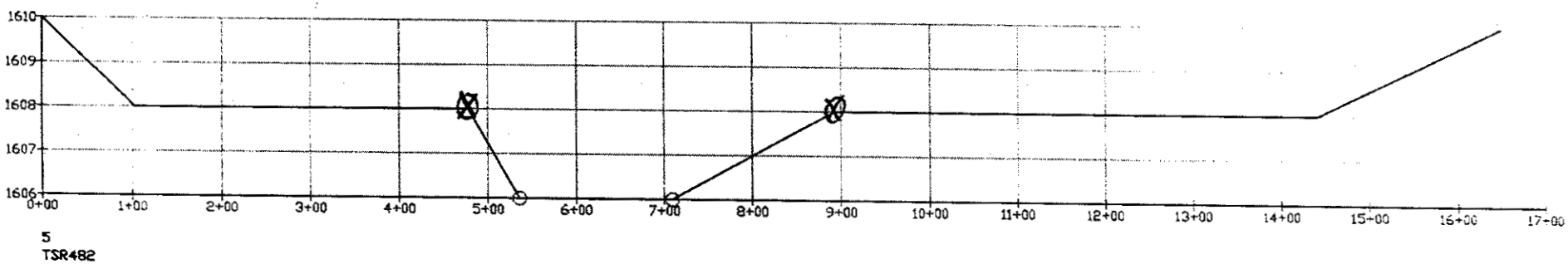
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR375
Date : 3/17/2003

By : US Date : 3/17/4
Ckd : CL Date : 3/18/4

	Station(ft)	Elevation(ft)
	0	1610
n-value station	102	1608
	478	1608
	535	1606
	709	1606
n-value station	892	1608
	1441	1608
	1649	1610



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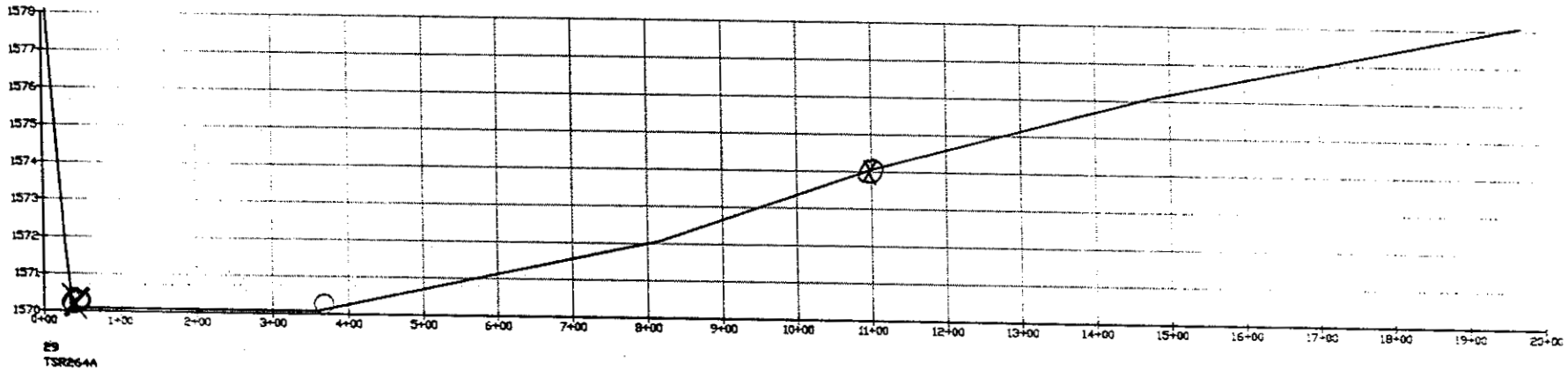
CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR482
Date : 3/17/2003

By : UJS Date : 3/17/4
Ckd : CJL Date : 3/18/4

Station(ft)	Elevation(ft)	
0	1578	
22	1572	
32	1570	– n-value station
353	1570	
813	1572	
1098	1574	– n-value station
1469	1576	
1965	1578	



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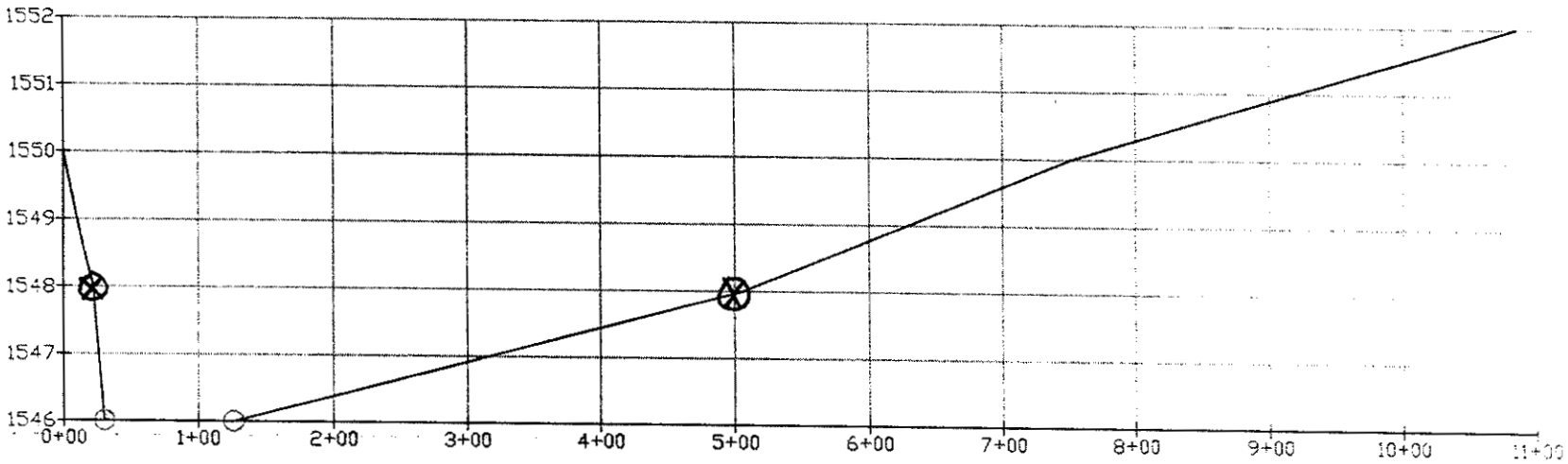
CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR264A
Date : 3/17/2003

By : JS Date : 3/17/4
Ckd : CJC Date : 3/18/4

	Station(ft)	Elevation(ft)
	0	1550
	10	1549
n-value station	22	1548
	30	1546
	126	1546
n-value station	506	1548
	751	1550
	1085	1552



3
TSR478

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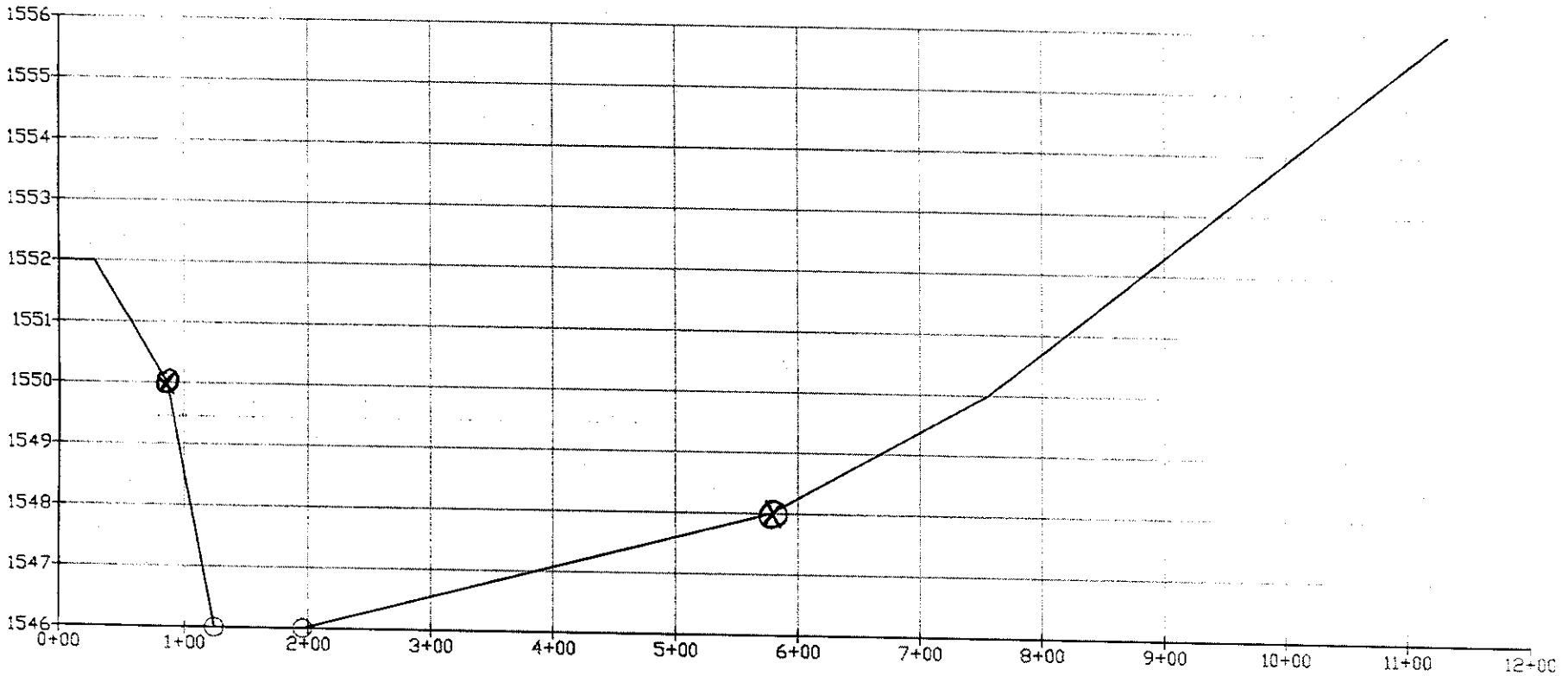
CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR478
Date : 3/17/2003

By : WS Date : 3/17/4
Ckd : CSL Date : 3/18/04

Station(ft)	Elevation(ft)	
0	1552	
29	1552	
86	1550	– n-value station
123	1546	
195	1546	
577	1548	– n-value station
756	1550	
1133	1556	



2
TSR429

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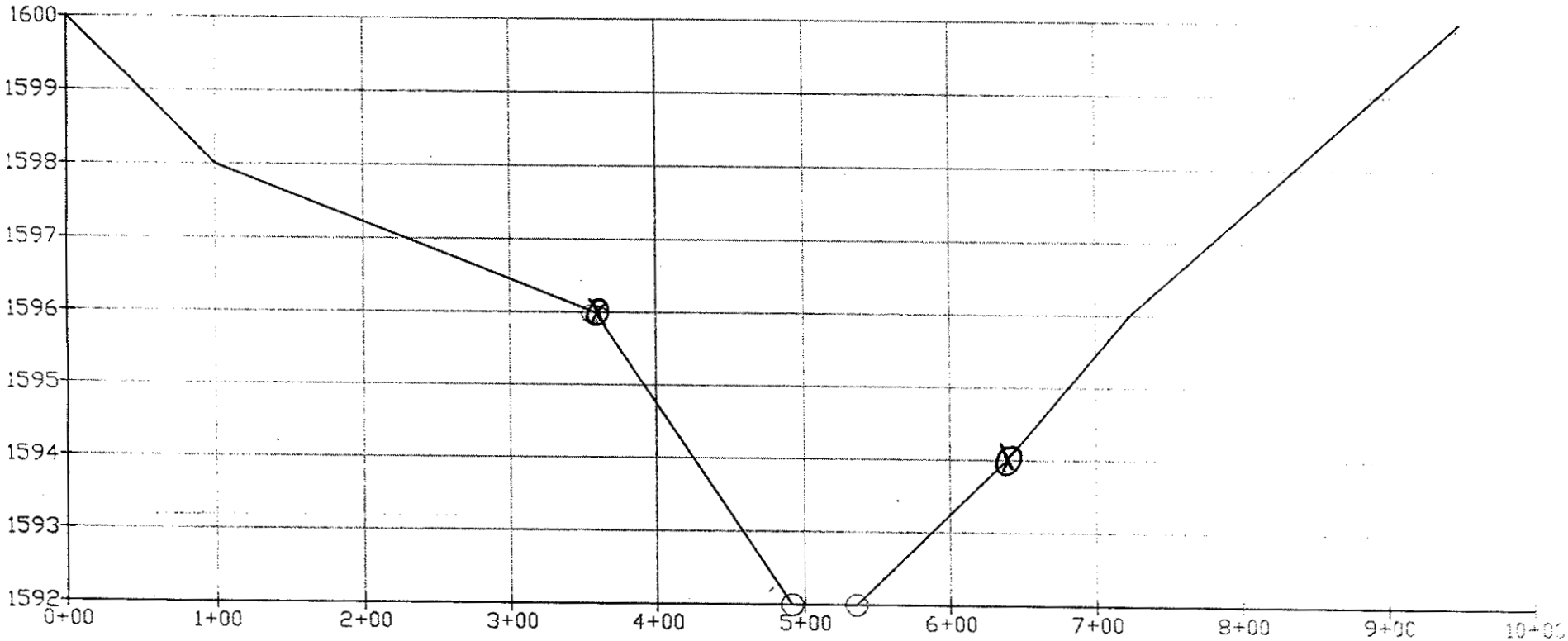
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR429
Date : 3/17/2003

By : VS Date : 3/17/4
Ckd : CSL Date : 3/18/4

Station(ft)	Elevation(ft)
0	1600
100	1598
359	1596 — n-value station
491	1592
535	1592
639	1594 — n-value station
723	1596
950	1600



14
TSR294

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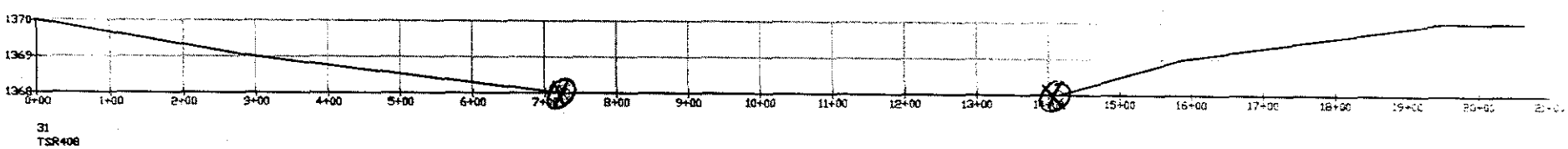
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR294
Date : 3/17/2003

By : VS Date : 3/17/4
Ckd : CJL Date : 3/18/4

Pt ID.	Station(ft)	Elevation(ft)
1	0	1370
2	301	1369
n value station — 3	727	1368
n value station — 6	1413	1368
7	1590	1369
8	1949	1370
	~~2001~~	~~1370~~
	~~2065~~	~~1370~~
4	900	1368
5	1200	1368



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CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR408
Date : 3/17/2003

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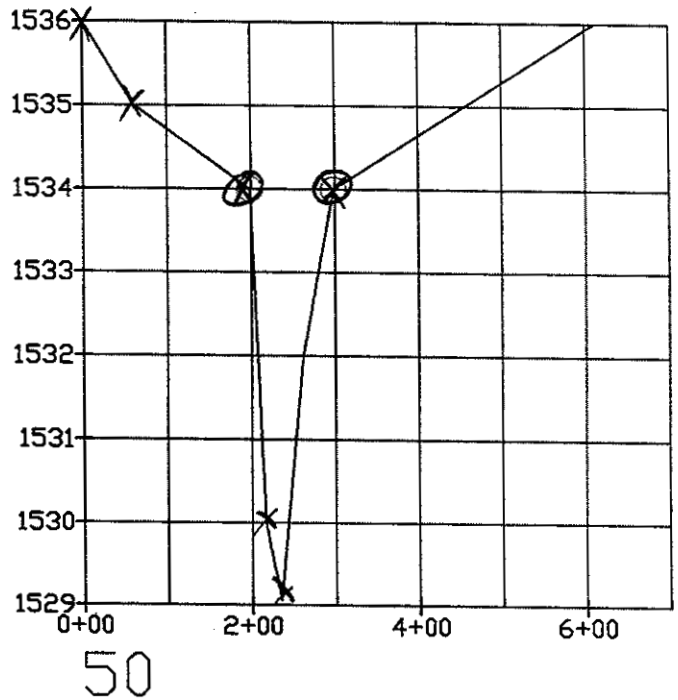
By : _____ Date : _____
Ckd : CJL Date : 2/3/4



Pt ID	Station [ft]	Elevation [ft]
1	0	1536
2	52	1535
3	199	1534
4	216	1530
5	234	1529
	~~262~~	~~1532~~
6	295	1534
7	611	1536
8	700	1536

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CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-50 Date : 9/22/2003 Pg : 9 of 9

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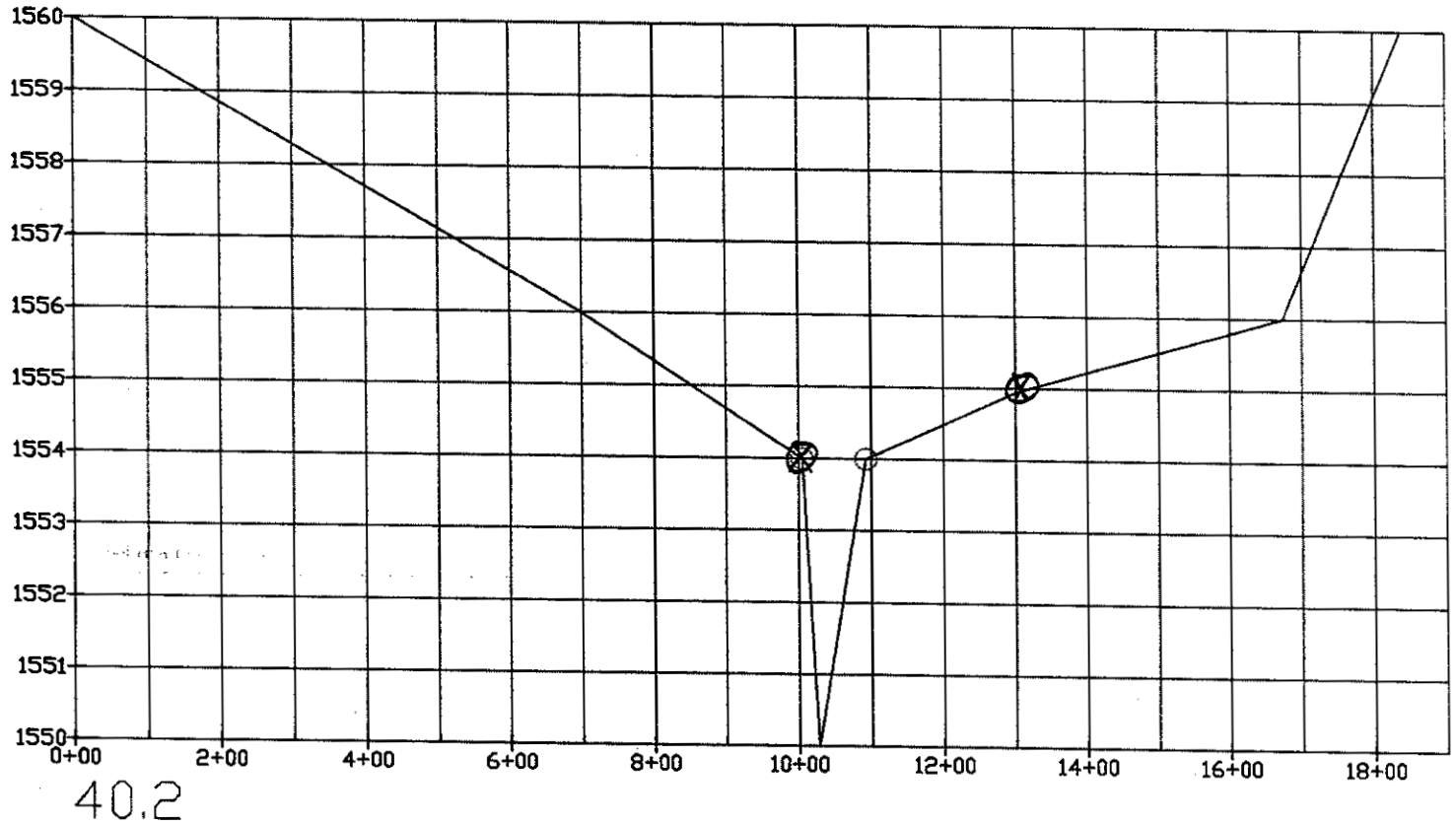
By : _____ Date : _____
Ckd : CJZ Date : 2/3/4



Station [ft]	Elevation [ft]	
0	1560	
699	1556	
1005	1554	-3
1035	1550	
1093	1554	
1320	1555	-6
1673	1556	
1838	1560	

3: n value station
6: n value station

Class #02

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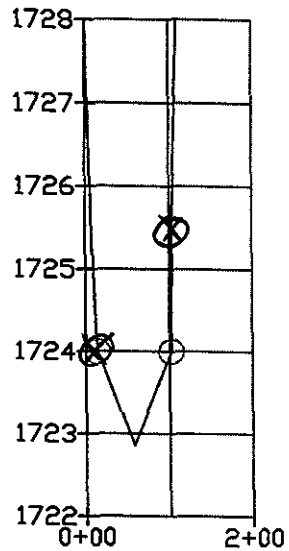
CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-40.2 Date : 9/22/2003 Pg : 8 of 9

P:\300\310\310032\HEC\X-Section Geometry\IW-TS.dwg

By : _____ Date : _____
Ckd : CJC Date : 2/3/4



30.2

Station [ft]	Elevation [ft]	
0	1728	
6.5	1725.5	
13	1724	- n value station
57	1723	
102	1724	
104	1725.5	- n value station
109	1727	
110	1728	

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CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-30.2 Date : 9/22/2003 Pg : 6 of 9

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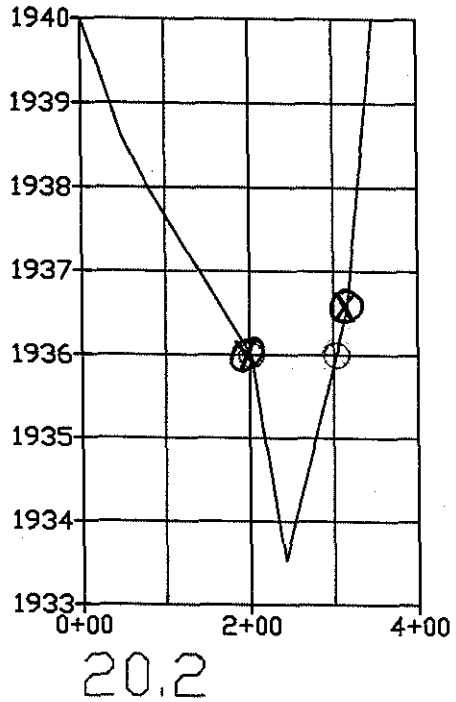
By : _____ Date : _____
Ckd : CJL Date : 2/3/1



Station [ft]	Elevation [ft]	
0	1940	
~~57~~	~~1939.5~~	
79	1938	
201	1936	— n-value station
242	1933.5	
303	1936	
327	1936.5	— n-value station
346	1940	
350	1940	

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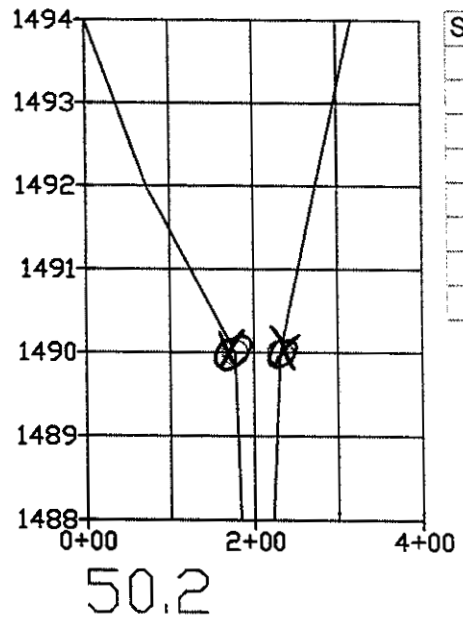
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
IONA WASH
Section : IW-TS-20.2 Date : 9/22/2003 Pg : 4 of 9

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CJL Date : 2/3/4



Station [ft]	Elevation [ft]	
0	1494	
73	1492	
178	1490	- n-value station
183	1488	
222	1488	
232	1490	- n-value station
274	1492	
318	1494	

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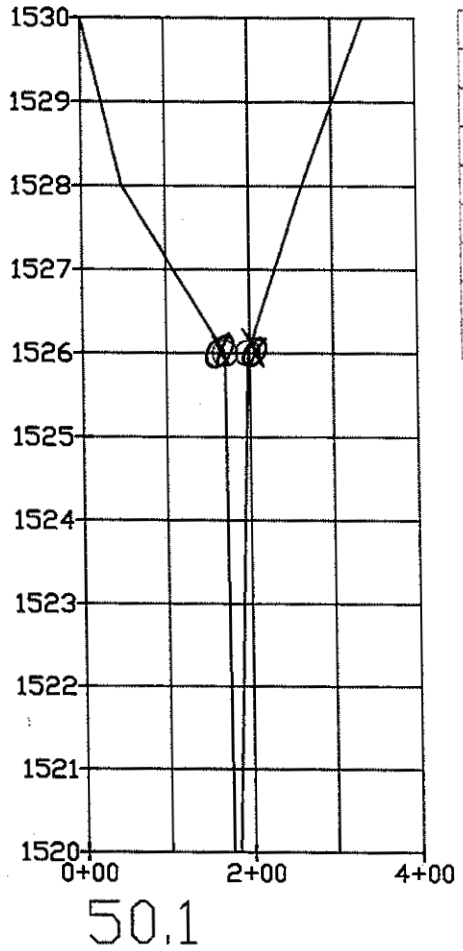
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-50.2 Date : 9/22/2003 Pg : 7 of 7

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CL Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1530	
48	1528	
170	1526	– n-value station
175	1520	
182	1520	
198	1526	– n-value station
264	1528	
338	1530	

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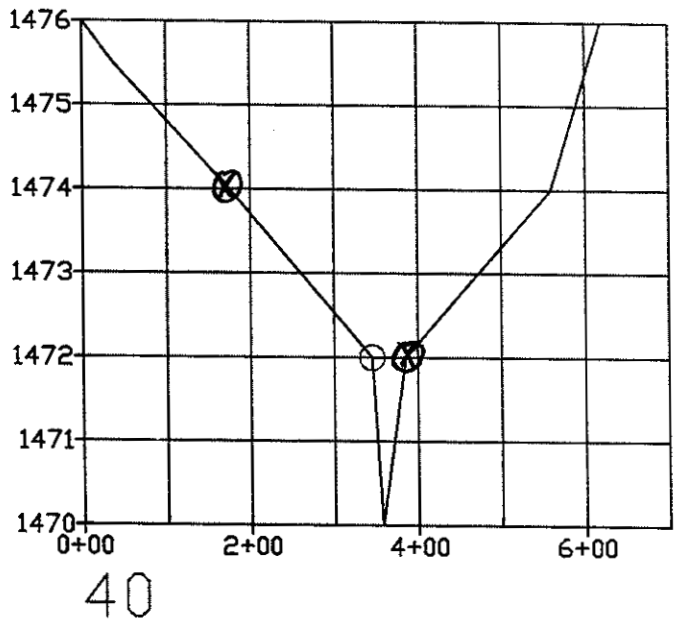
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-50.1 Date : 9/22/2003 Pg : 6 of 7

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CR Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1476	
45	1475.5	
175	1474	- n-value station
345	1472	
357	1470	
386	1472	- n-value station
559	1474	
620	1476	

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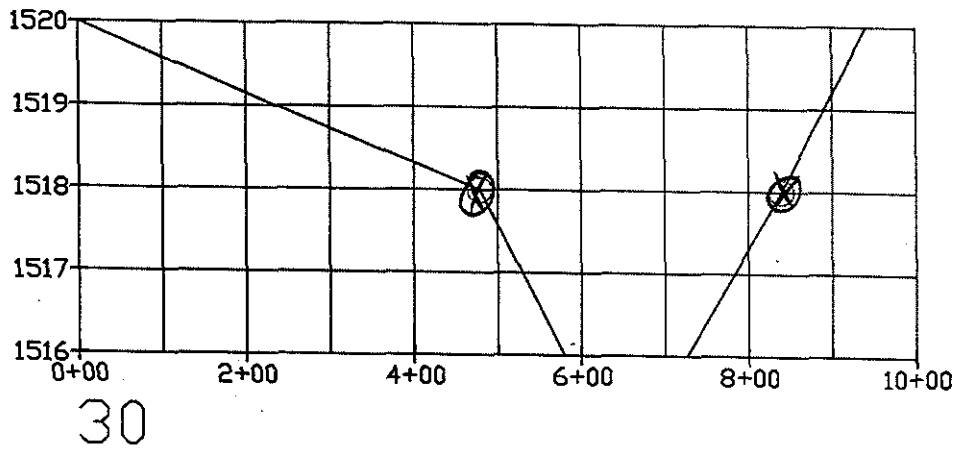
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-40 Date : 9/22/2003 Pg : 5 of 7

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CJL Date : 2/3/4



Station [ft]	Elevation [ft]	
0	1520	
237	1519	
478	1518	- n-value station
580	1516	
726	1516	
839	1518	- n-value station
890	1519	
941	1520	

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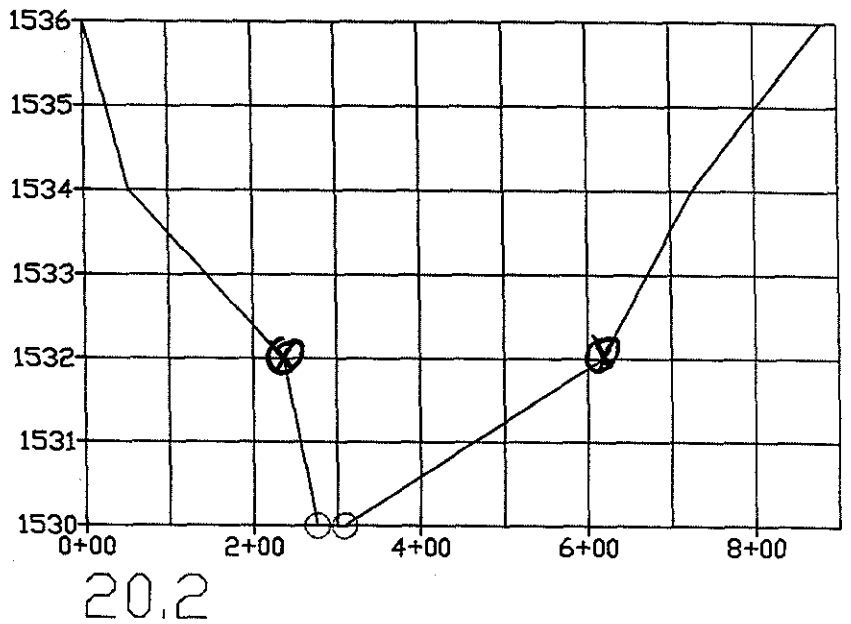
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-30 Date : 9/22/2003 Pg : 4 of 7

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CSL Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1536	
53	1534	
236	1532	– n-value station
276	1530	
309	1530	
617	1532	– n-value station
725	1534	
881	1536	

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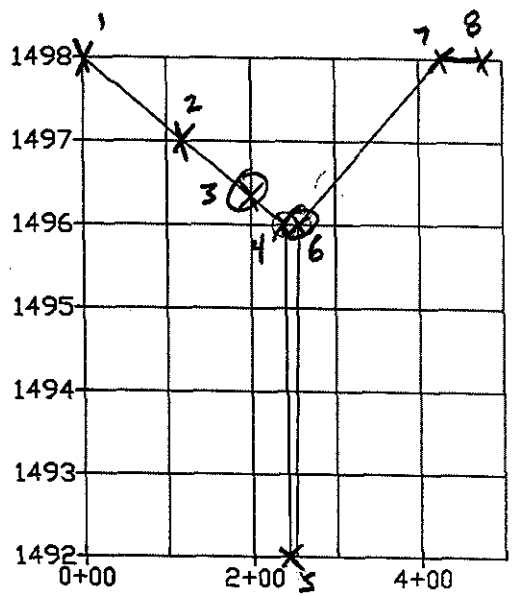
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-20.2 Date : 9/22/2003 Pg : 3 of 7

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CSL Date : 2/3/04



20.1

Pt ID	Station [ft]	Elevation [ft]	
1	0	1498	
4	240	1496	
	~~241~~	~~1494~~	
	~~243~~	~~1492~~	
5	251	1492	
	~~253~~	~~1494~~	
6	256	1496	— n value station
7	425	1498	
2	120	1497	
3	200	1496.5	— n value station
8	450	1498	

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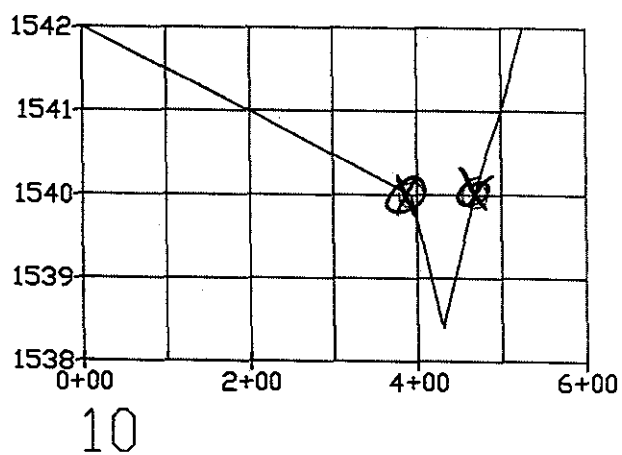
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-20.1 Date : 9/22/2003 Pg : 2 of 7

P:\300\310\310032 \HEC\X-Section Geometry\SV-TS.dwg

By : _____ Date : _____
Ckd : CSL Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1542	
201	1541	
393	1540	- n-value station
430	1538.5	
468	1540	
473	1540	- n-value station
500	1541	
525	1542	

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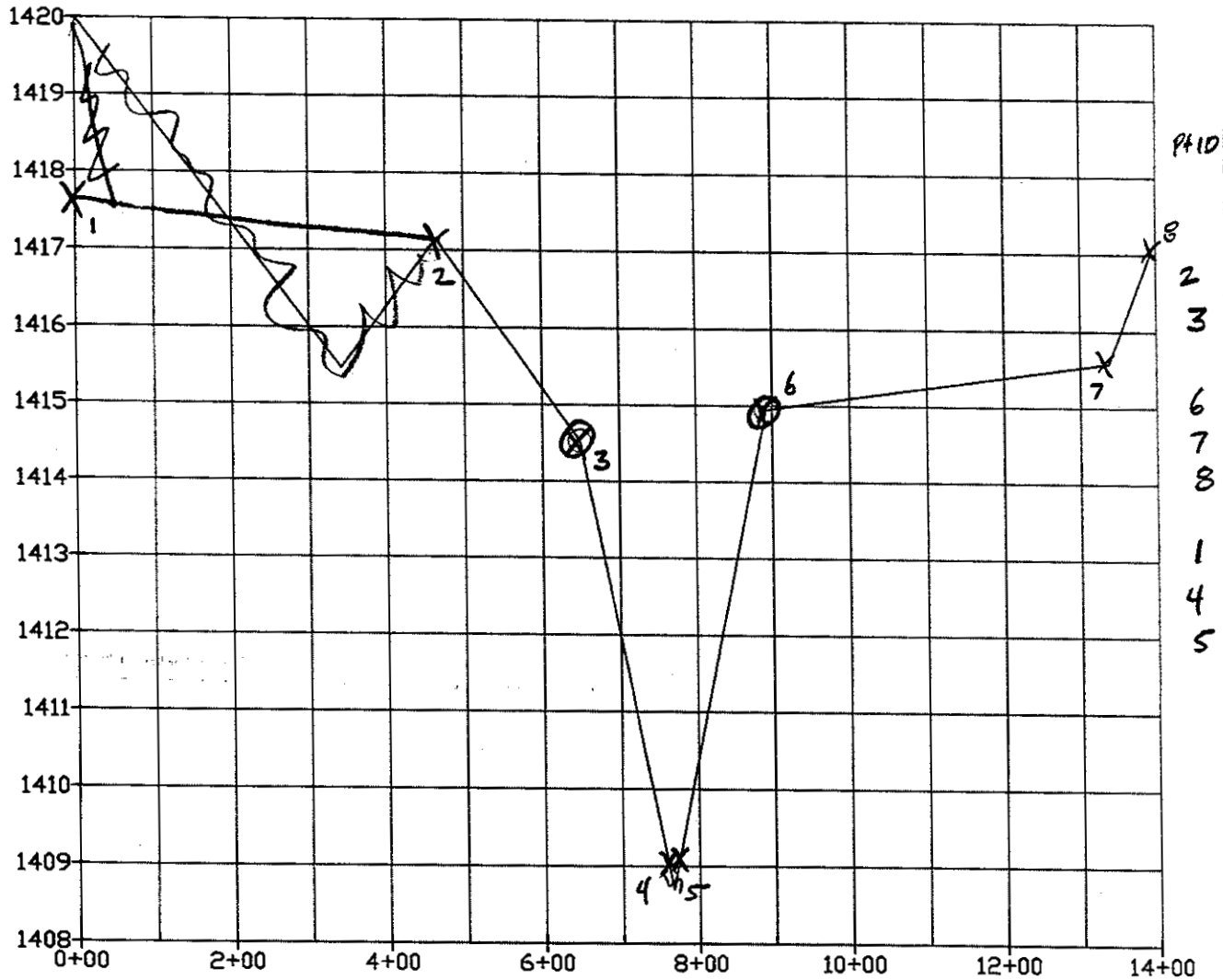
CHANNEL ROUTING TYPICAL CROSS-SECTION
SUN VALLEY WASHES
Section : SV-TS-10 Date : 9/22/2003 Pg : 1 of 7

P:\300\310\310032 \HEC\X-Section Geometry\TW-TS.dwg

By : _____ Date : _____
Ckd : BZ Date : 2/3/04



Pt ID	Station [ft]	Elevation [ft]
	~~0~~	~~1420~~
	~~341~~	~~1415.5~~
2	465	1417
3	648	1414.5
	~~766~~	~~1408.5~~
6	892	1415
7	1337	1415.5
8	1400	1417
1	0	1417.5
4	750	1409
5	760	1409

- n value station

50

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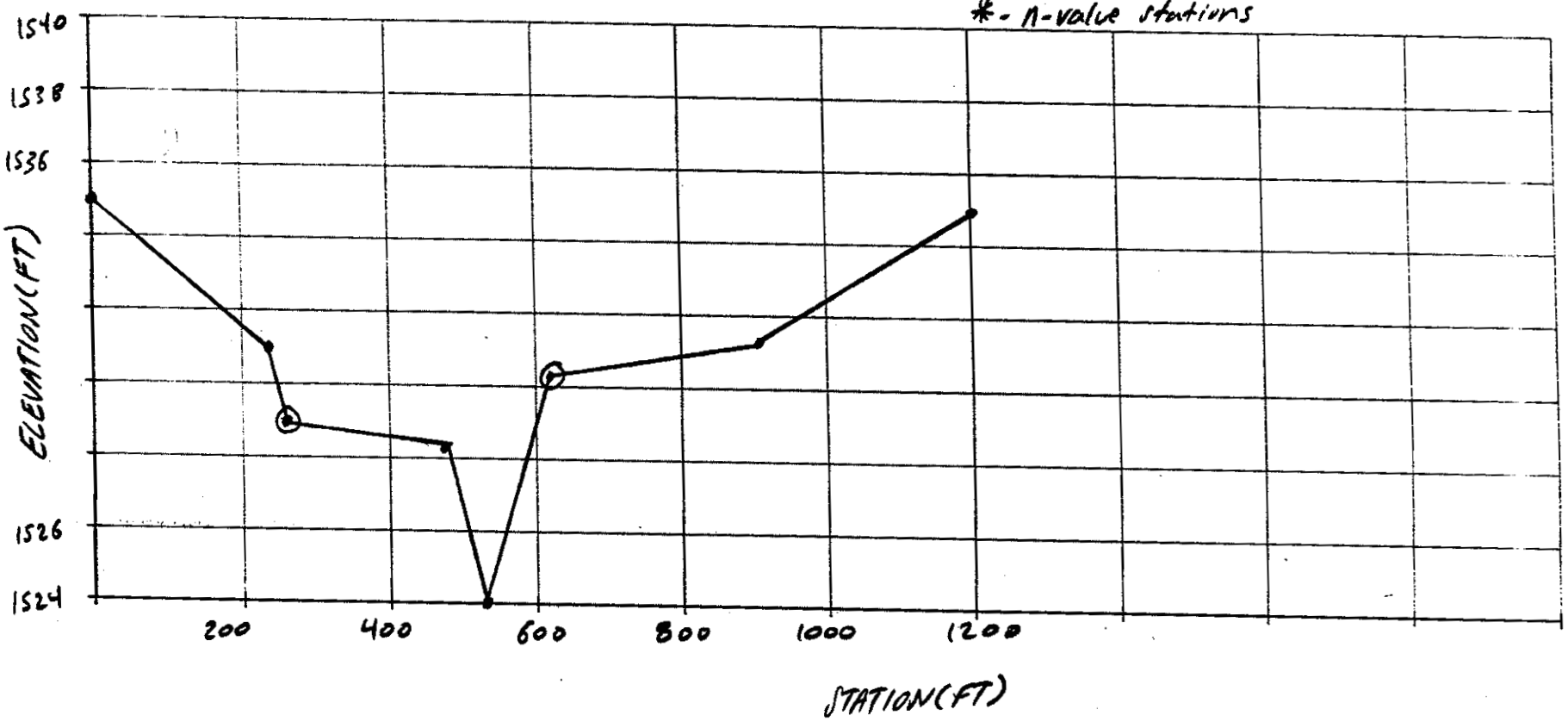
CHANNEL ROUTING TYPICAL CROSS-SECTION
TRILBY WASH
Section : TW-TS-50 Date : 9/22/2003 Pg : 5 of 5

P:\300\310\310032 \HEC\X-Section Geometry\PD-TS.dwg

By: JCS Date: 2/3/4
Ckd: CJL Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1535	
250	1531	
290	1529	*
491	1528.5	
543	1524	
606	1530.5	*
920	1531	
1197	1534.5	

*- n-value stations



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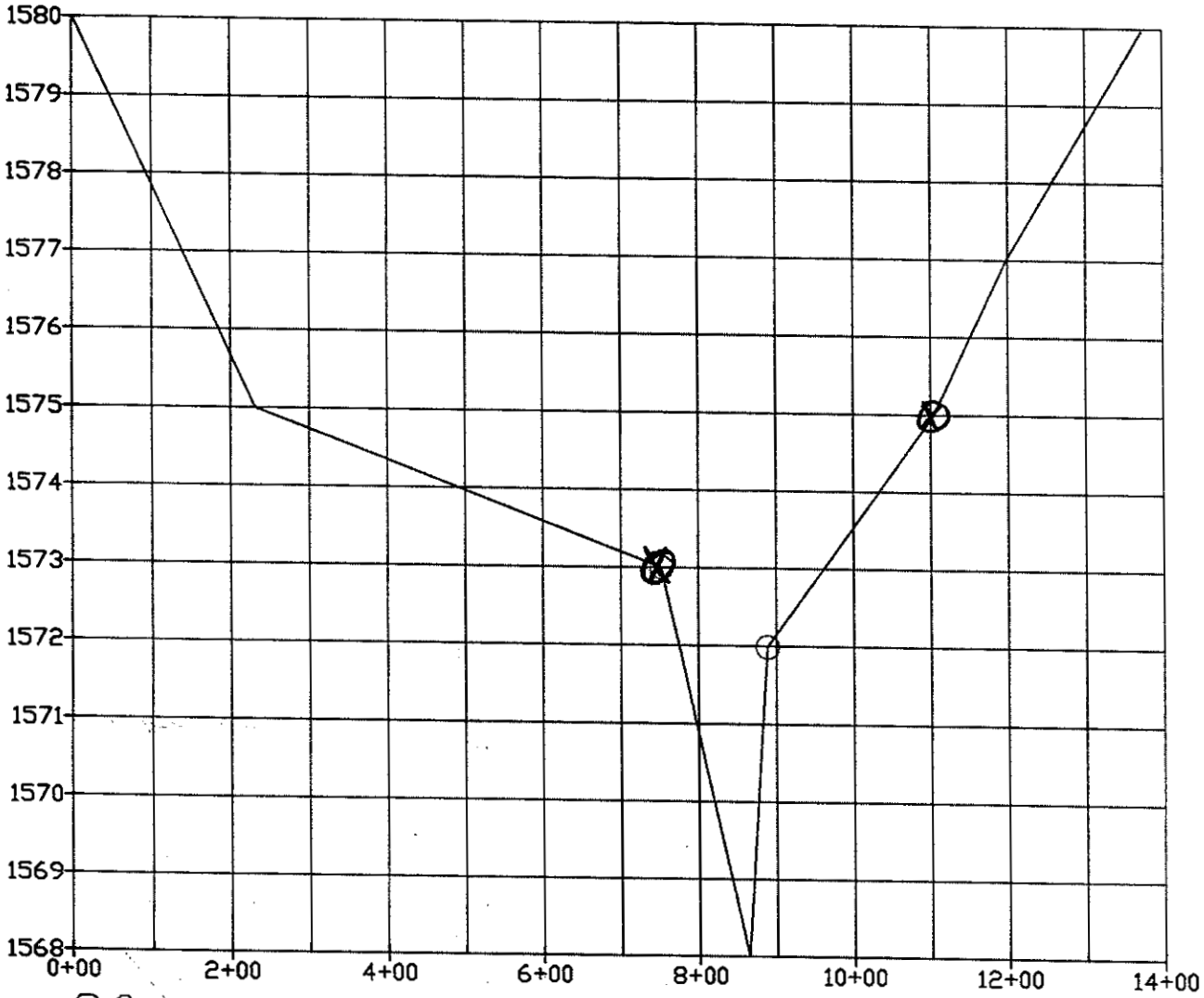
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
TW-TS-40
Date: 4/20/2004

P:\300\310\310032 \HEC\X-Section Geometry\TW-TS.dwg

By : _____ Date : _____
Ckd : CSL Date : 2/3/04



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Station [ft]	Elevation [ft]	
0	1580	
219	1575	
753	1573	—n-value station
855	1568	
880	1572	
1110	1575	—n-value station
1198	1577	
1380	1580	

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
TRILBY WASH
Section : TW-TS-30 Date : 9/22/2003 Pg : 3 of 5

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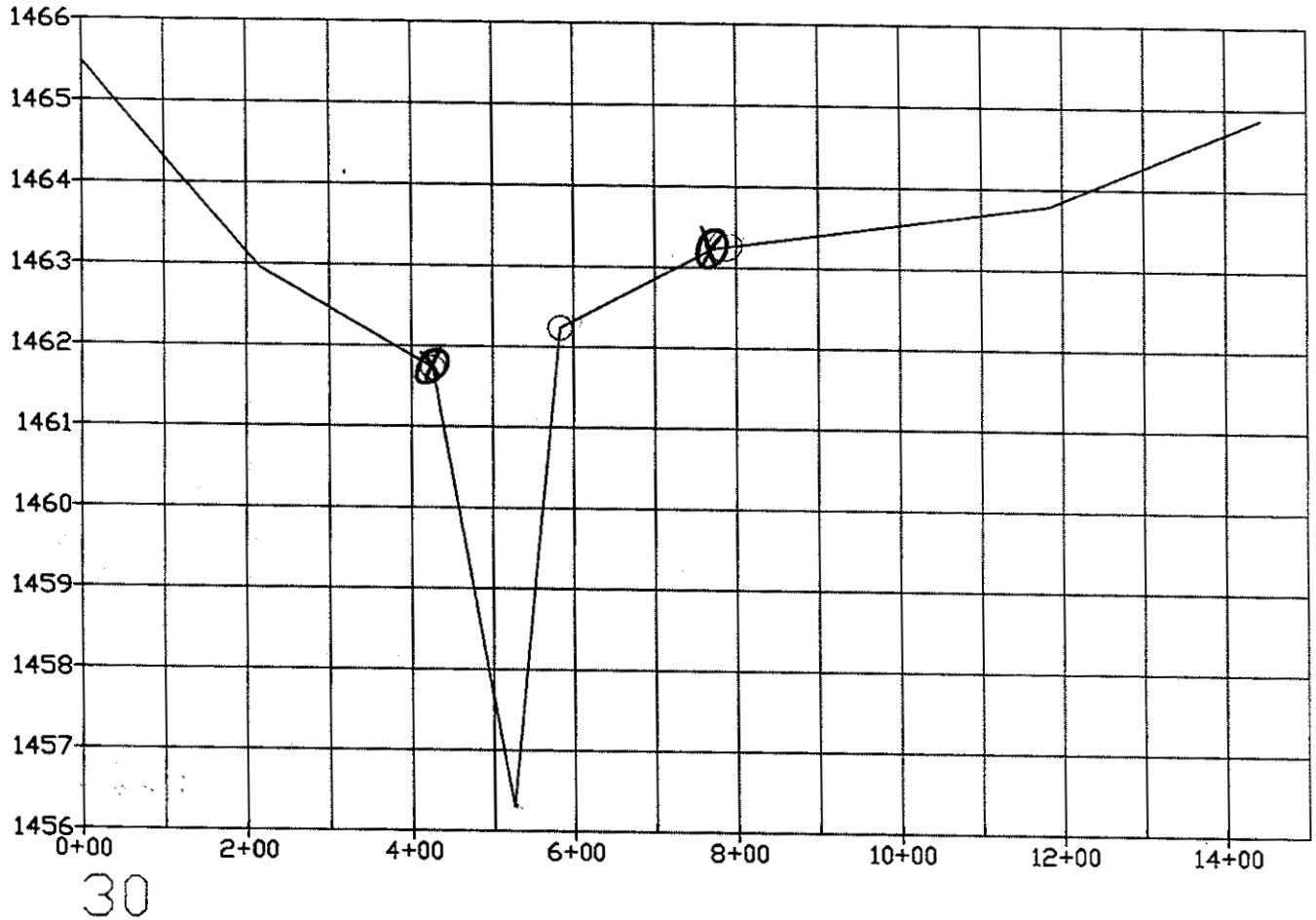
By : _____ Date : _____
Ckd : CSL Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1465.5	
216	1463	
426	1462	- n-value Station
525	1456	
583	1462	
771	1463	- n-value Station
1184	1464	
1444	1465	

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CONTRACT FCD 2002C029

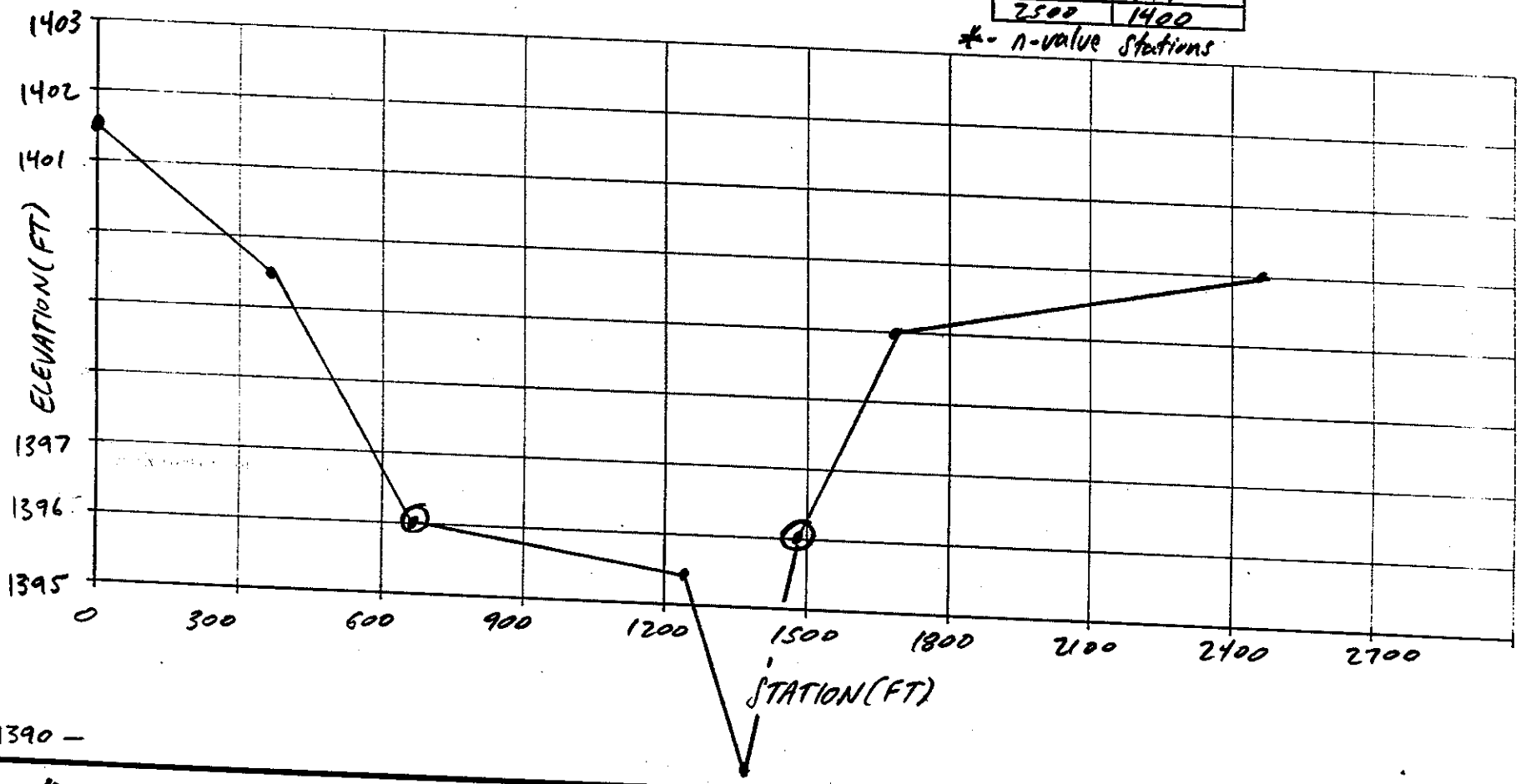
CHANNEL ROUTING TYPICAL CROSS-SECTION
WITTMANN WASHES
Section : WI-TS-30 Date : 9/22/2003 Pg : 3 of 13

P:\300\310\310032 \HEC\X-Section Geometry\FD-TS.dwg

By: JS Date: 2/3/4
Ckd: CJL Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1401.5	
450	1399.5	
700	1396	*
1284	1395.5	
1435	1390	
1499	1396	*
1745	1399	
2500	1400	

*- n-value Stations



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CONTRACT FCD 2002C029

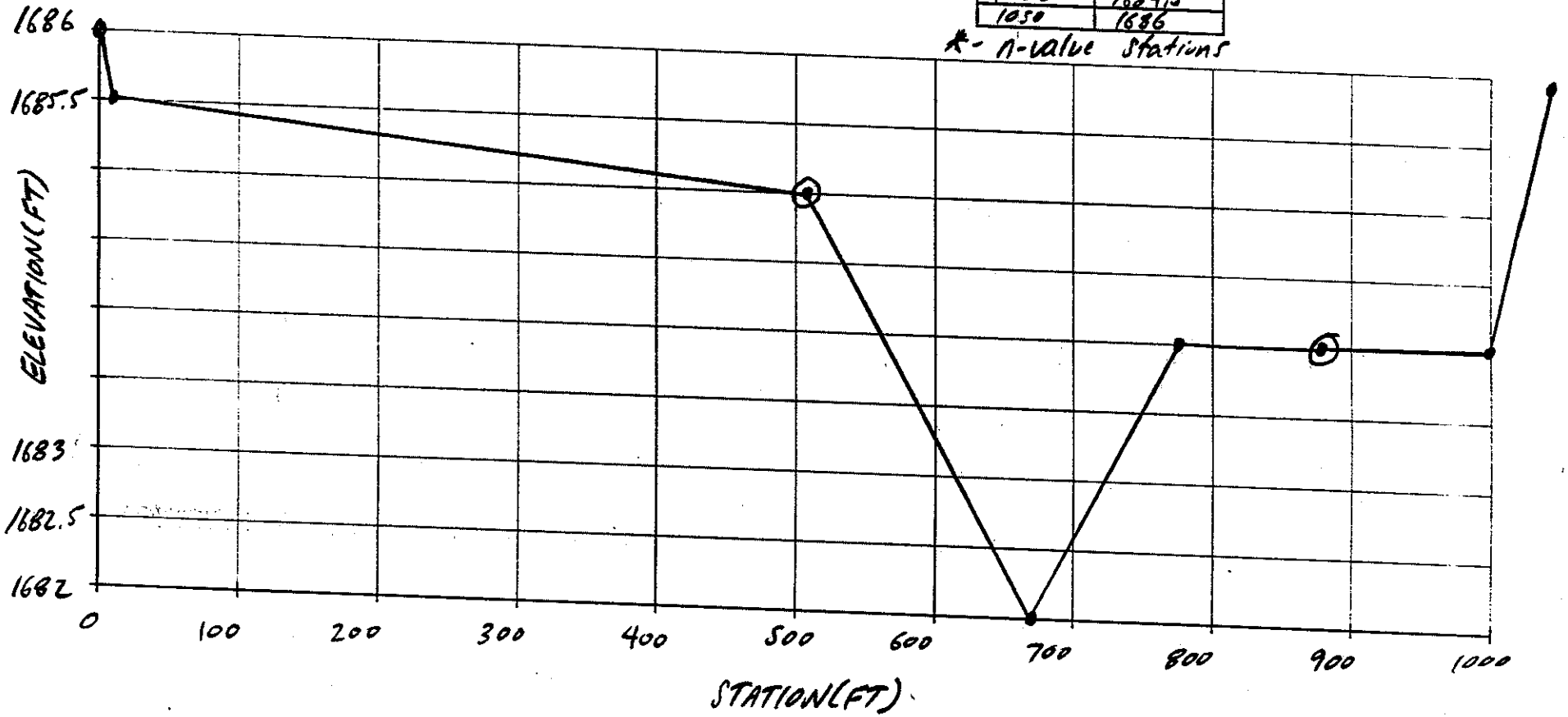
CHANNEL ROUTING TYPICAL CROSS-SECTION
WI-TS-70
Date: 4/20/2004

P:\300\310\310032 \HEC\X-Section Geometry\FD-TS.dwg

By: JCF Date: 2/3/4
Ckd: CJL Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1686	
10	1685.5	
515	1685	*
673	1682	
779	1684.5	
880	1684.5	*
1000	1684.5	
1050	1686	

*- n-value stations



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CONTRACT FCD 2002C029

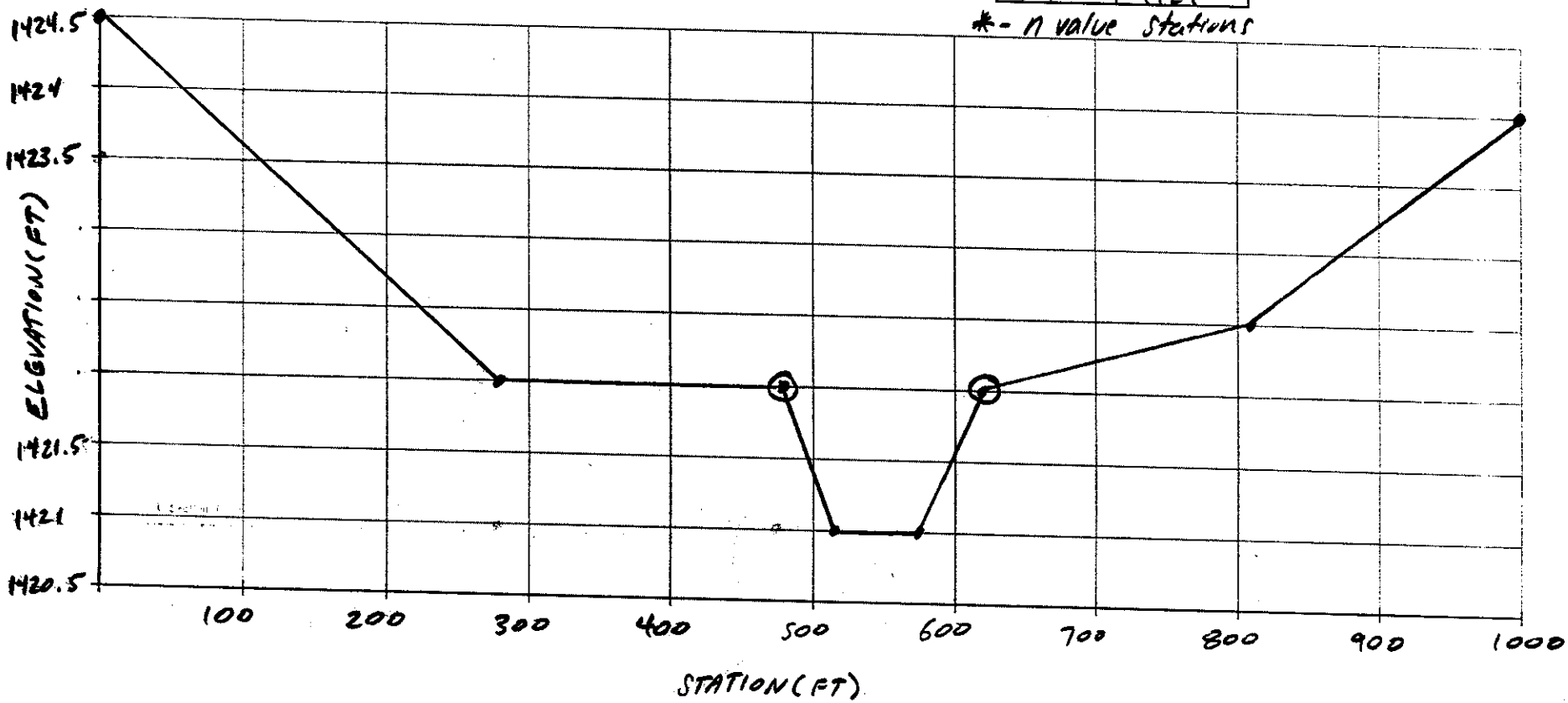
CHANNEL ROUTING TYPICAL CROSS-SECTION
WI-TS-20
Date: 4/20/2004

South Region Typical Sections

By: JS Date: 2/3/4
Ckd: CJC Date: 2/3/4

Station(ft)	Elevation(ft)	
0	1424.5	
280	1422	
475	1422	*
520	1421	
570	1421	
618	1422	*
803	1422.5	
1036	1424	

*- n value Stations



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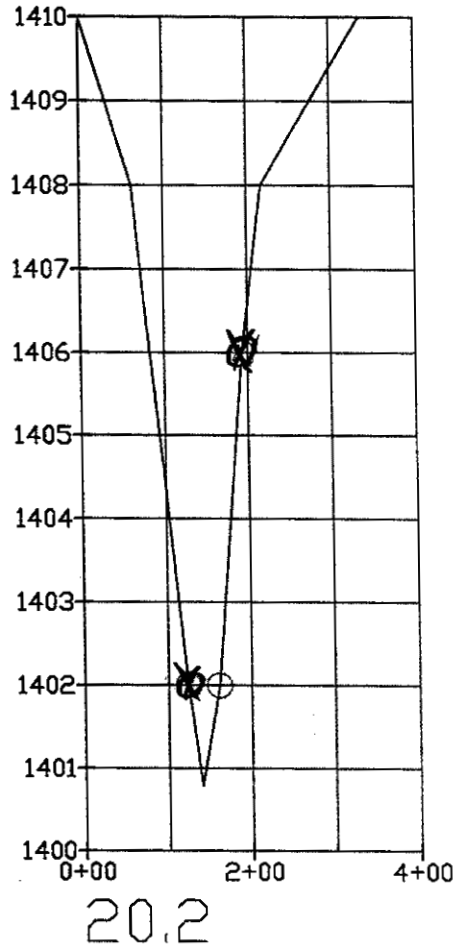
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
WT-TS-10.1
Date: 4/20/2004

By : _____ Date : _____
Ckd : CJZ Date : 2/3/04



Station [ft]	Elevation [ft]	
0	1410	
62	1408	
124	1402	— n-value station
140	1401	
161	1402	
193	1406	— n-value station
217	1408	
336	1410	

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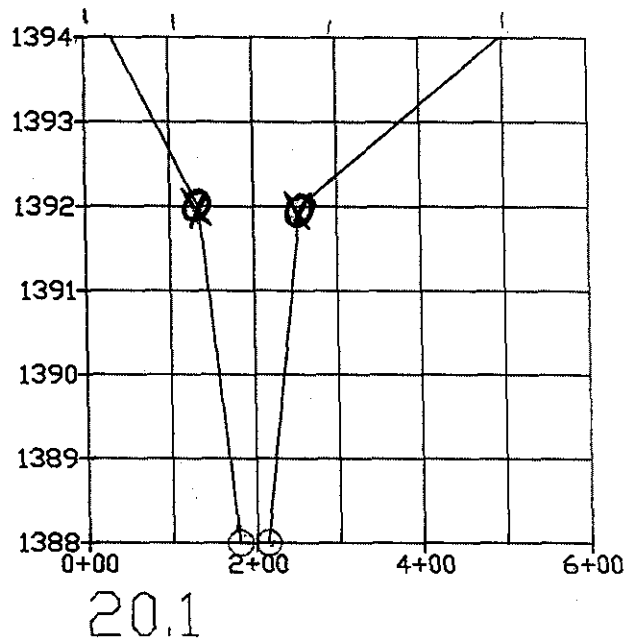
CONTRACT FCD 2002C029

CHANNEL ROUTING TYPICAL CROSS-SECTION
WHITE TANK WASHES
Section : WT-TS-20.2 Date : 9/22/2003 Pg : 4 of 4

P:\300\310\310032 \HEC\X-Section Geometry\WT-TS.dwg

By : _____ Date : _____
Ckd : CJL Date : 2/2/04



Station [ft]	Elevation [ft]	
0	1394	
33	1394	
134	1392	- n-value station
180	1388	
213	1388	
256	1392	- n-value station
496	1394	
507	1394	

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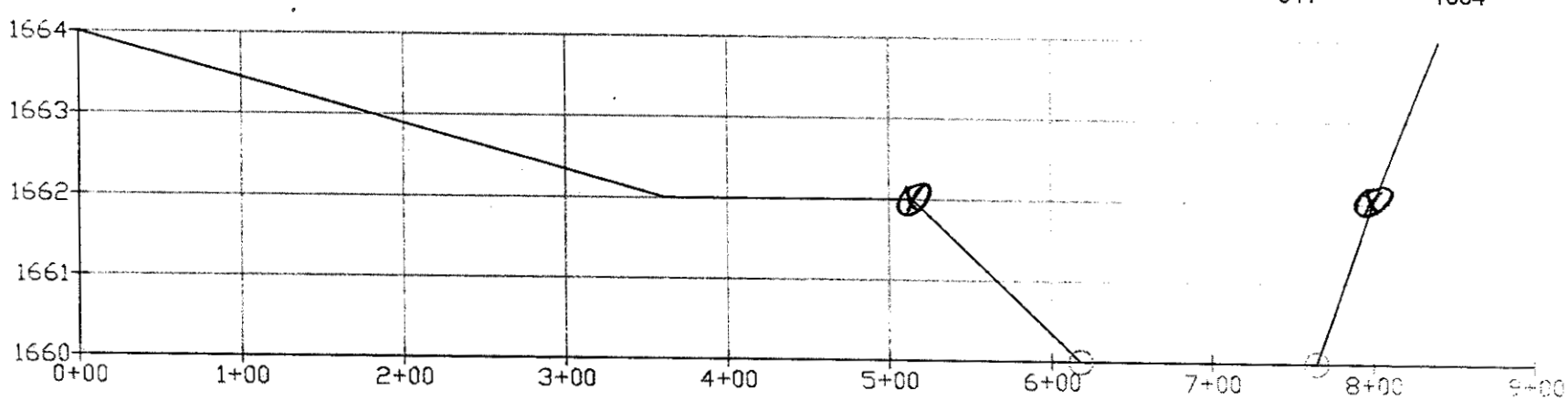
CHANNEL ROUTING TYPICAL CROSS-SECTION
WHITE TANK WASHES
Section : WT-TS-20.1 Date : 9/22/2003 Pg : 3 of 4

By : US Date : 3/17/4
Ckd : CSL Date : 3/18/4

	Station(ft)	Elevation(ft)
	0	1664
	362	1662
n-value station —	515	1662
	618	1660
	765	1660
n-value station —	800	1662
	820	1663
	841	1664



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TSR248

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CHANNEL ROUTING TYPICAL CROSS-SECTION
TSR248
Date : 3/17/2003

D.3.3 NSTEP Check Data: 100-yr 24-hr Existing Conditions

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWT140	13.00	13.33	0.33	13053	10.99	6.41	1804	1811	WTTS20_1	0.019	0.035	4
RWT130	13.25	13.75	0.50	5750	3.19	4.16	2441	2450	Channel	0.001	0.035	5
RWT160	12.58	14.25	1.67	18961	3.15	2.35	376	384	WTTS10_1	0.012	0.035	12
R150A	12.92	13.17	0.25	9557	10.62	9.31	2601	2609	WTTS20_2	0.021	0.035	2
RWT150	13.08	13.50	0.42	16082	10.64	6.29	2875	2881	WTTS20_1	0.013	0.035	7
RWT120	13.50	14.08	0.58	6168	2.95	5.27	5726	5735	Channel	0.001	0.035	7
RWT110	14.08	14.75	0.67	7640	3.17	5.21	5507	5516	Channel	0.001	0.035	5
RWT100	14.75	15.08	0.33	4778	4.02	5.15	5251	5260	Channel	0.001	0.035	1
RTW406	12.08	16.67	4.59	14969	0.91	0.50	30	21	TSR408	0.008	0.04	6
RTW408	12.83	16.00	3.17	16567	1.45	1.17	213	220	TSR408	0.007	0.04	10
RTW404	15.17	15.42	0.25	2936	3.26	5.13	5210	5219	Channel	0.001	0.035	2
RIW371	12.08	14.58	2.50	11583	1.29	0.34	13	3	TSR371	0.009	0.04	15
RIW366	12.58	13.00	0.42	9657	6.39	4.52	771	780	IWTS30_2	0.007	0.04	6
RIW377	12.42	13.25	0.83	6588	2.20	0.93	67	58	TSR371	0.010	0.04	6
RD371	12.08	12.33	0.25	1409	1.57	0.59	26	16	WITS130	0.001	0.035	1
RIW374	12.33	14.17	1.84	20437	3.09	1.40	279	288	TSR371	0.008	0.04	15
RIW386	12.67	13.75	1.08	10311	2.65	2.35	208	217	IWTS20_1	0.008	0.035	6
RIW382	12.33	12.83	0.50	4964	2.76	1.49	212	220	TSR371	0.012	0.04	3
RD382A	12.33	12.42	0.09	1172	3.62	1.44	60	50	WITS130	0.007	0.035	1
RIW384	12.33	12.75	0.42	4694	3.10	1.29	120	129	TSR371	0.012	0.04	3
RIW381	12.50	12.92	0.42	4964	3.28	1.69	460	467	TSR371	0.010	0.04	3
R359*	12.83	13.25	0.42	9280	6.14	4.96	719	728	IWTS30_2	0.010	0.04	4
RIW359 **	12.92	13.25	0.33	13031	10.97	6.95	2943	2952	IWTS30_2	0.006	0.04	5
RIW389	12.50	13.92	1.42	11459	2.24	1.06	76	67	TSR371	0.012	0.04	6
RIW394	13.00	13.17	0.17	7697	12.58	7.68	2473	2481	IWTS10_1	0.013	0.035	3
R390A	13.17	13.42	0.25	8577	9.53	7.97	2827	2834	IWTS10_1	0.013	0.035	4

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW390	13.42	13.75	0.33	11626	9.79	6.29	2891	2898	IWTS20_1	0.010	0.035	5
RIW388	13.75	14.00	0.25	7726	8.58	5.80	3364	3372	IWTS20_2	0.009	0.04	4
RIW357 **	14.00	14.50	0.50	16693	9.27	6.02	2494	2502	IWTS30_1	0.008	0.04	9
RIW353	13.33	13.75	0.42	7496	4.96	4.03	4898	4904	IWTS40_1	0.005	0.04	2
RIW312	12.92	13.75	0.83	8292	2.78	3.20	228	238	TSR375	0.010	0.04	1
RD312	12.92	13.00	0.08	1034	3.59	1.70	86	76	WITS130	0.008	0.035	1
RIW365	13.00	13.50	0.50	7351	4.08	3.68	282	291	IWTS30_1	0.009	0.04	5
RD365	13.00	13.17	0.17	1700	2.78	1.65	58	48	WITS130	0.011	0.035	2
RIW369	13.08	13.42	0.34	6797	5.55	3.26	266	275	TSR375	0.009	0.04	4
RD357	14.00	14.08	0.08	2791	9.69	4.70	926	935	IWTS30_1	0.008	0.04	2
RIW363	14.00	14.33	0.33	11127	9.37	4.86	1098	1107	IWTS30_1	0.008	0.04	4
RD369	13.00	13.25	0.25	1927	2.14	1.99	205	214	WITS130	0.005	0.035	1
RIW368	13.17	13.75	0.58	11648	5.58	3.46	270	279	TSR375	0.010	0.04	6
RIW360	12.25	12.42	0.17	2593	4.24	2.60	635	643	TWTS20	0.008	0.035	1
RIW397	12.83	13.42	0.59	21294	10.03	7.41	3396	3399	TWTS10	0.021	0.035	8
RIW395	13.17	13.42	0.25	13324	14.80	8.76	7399	7404	TWTS10	0.017	0.035	4
RIW387 + **	12.67	12.67	0.08	1005	3.35	3.70	1106	1114	TWTS20	0.014	0.035	1
RIW396	13.33	13.50	0.17	6512	10.64	8.41	7858	7863	TWTS10	0.014	0.035	2
RIW380 **	13.50	14.58	1.08	16914	4.35	5.40	5542	5547	TWTS20	0.013	0.035	11
RIW370 **	14.58	15.08	0.50	7248	4.03	4.77	5390	5394	TWTS20	0.010	0.035	3
RIW349	15.08	15.17	0.09	4331	13.37	4.55	2047	2053	TWTS20	0.016	0.035	2
RD349	15.08	15.42	0.34	4244	3.47	4.43	3194	3199	TWTS20	0.011	0.035	1
RIW356	15.25	15.42	0.17	2643	4.32	3.04	5244	5241	TSR371	0.009	0.04	1
RIW354	15.42	15.75	0.33	4523	3.81	2.84	5141	5145	TSR371	0.007	0.04	2
RIW372	12.33	13.50	1.17	15367	3.65	2.66	129	139	TSR375	0.010	0.04	9
RD372	12.33	12.50	0.17	1828	2.99	1.41	101	111	WITS130	0.003	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW375	13.00	13.75	0.75	13330	4.94	3.46	280	289	TSR375	0.010	0.04	8
RIW364	15.75	16.42	0.67	10402	4.31	2.87	5152	5150	TSR371	0.007	0.04	7
RD363	14.00	14.08	0.08	3820	13.26	4.34	514	523	IWTS30_1	0.009	0.04	1
RIW351	13.42	16.50	3.08	24311	2.19	1.70	68	58	IWTS30_2	0.008	0.04	10
RIW346	16.42	16.58	0.16	3706	6.43	4.31	5213	5220	TWTS30	0.005	0.04	2
RIW338	16.58	17.00	0.42	7227	4.78	4.59	5156	5161	TWTS30	0.006	0.04	5
RIW326	12.42	13.00	0.58	8066	3.86	1.97	235	244	TWTS30	0.006	0.04	5
RIW334	17.08	17.92	0.84	21501	7.11	4.97	5060	5067	TWTS40	0.007	0.04	12
RD351	13.42	13.83	0.41	6586	4.46	3.93	475	484	IWTS30_1	0.008	0.04	3
RIW361	14.17	14.83	0.66	17152	7.22	4.97	1591	1600	IWTS30_1	0.006	0.04	12
R350*	13.83	14.08	0.25	8310	9.23	4.57	6462	6467	IWTS40_1	0.006	0.04	3
RIW330	14.08	14.25	0.17	2771	4.53	3.80	6525	6527	IWTS40_2	0.005	0.04	1
RIW322	14.25	14.92	0.67	12886	5.34	3.94	6912	6918	IWTS40_2	0.005	0.04	12
RIW318	12.75	14.58	1.83	17570	2.67	2.18	295	304	TSR294	0.005	0.04	15
RIW310	12.92	13.00	0.08	860	2.99	1.57	703	712	IWTS50	0.002	0.04	1
RIW314 **	15.17	16.42	1.25	20068	4.46	3.98	6916	6920	IWTS50	0.005	0.04	15
RIW300	16.42	16.83	0.41	6125	4.15	3.36	6759	6760	TWTS50	0.004	0.04	3
RIW302	17.25	17.58	0.33	5720	4.81	3.81	10637	10638	TWTS50	0.004	0.04	3
R264A	13.08	13.50	0.42	4042	2.67	2.12	1353	1360	TSR264A	0.003	0.04	1
RSV264	13.33	13.75	0.42	4870	3.22	2.33	1931	1938	TSR264A	0.003	0.04	1
RSV298	13.08	14.42	1.34	15129	3.14	2.61	450	459	TSR294	0.006	0.04	14
RSV286	12.75	13.00	0.25	3544	3.94	3.21	1023	1031	TSR294	0.006	0.04	1
RSV284	12.92	13.75	0.83	12013	4.02	3.22	931	940	TSR294	0.006	0.04	4
RSV290	12.58	13.75	1.17	13500	3.21	2.56	385	394	TSR294	0.006	0.04	5
RSV272	13.67	13.75	0.08	1628	5.65	3.94	1550	1559	SVTS50_1	0.006	0.04	1
RSV294	12.92	13.83	0.91	14316	4.37	3.58	1466	1473	TSR294	0.006	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RSV276	13.75	13.83	0.08	1016	3.53	4.14	3233	3241	SVTS50_1	0.004	0.04	1
RSV280	13.92	14.25	0.33	6288	5.29	3.85	3625	3633	SVTS50_1	0.003	0.04	3
RSV268	12.67	12.92	0.25	2946	3.27	2.09	1081	1090	SVTS50_1	0.001	0.04	1
RSV260	14.92	15.17	0.25	6946	7.72	4.64	4052	4060	SVTS50_1	0.005	0.04	5
RSV252	12.33	13.42	1.09	9744	2.48	1.42	62	52	SVTS10	0.009	0.04	5
RSV254	12.25	13.42	1.17	10928	2.59	1.29	45	35	SVTS10	0.010	0.04	6
RSV219	12.42	12.83	0.41	5058	3.43	2.22	786	795	SVTS10	0.004	0.04	3
RSV251	12.42	13.42	1.00	12592	3.50	1.92	126	135	SVTS10	0.010	0.04	8
RSV250	12.33	13.50	1.17	11765	2.79	1.49	61	51	SVTS10	0.011	0.04	8
RSV218	12.75	13.17	0.42	4698	3.11	2.50	1409	1416	SVTS10	0.004	0.04	2
RSV248	12.67	13.25	0.58	7772	3.72	2.96	324	332	TSR248	0.014	0.035	3
RD248	12.67	12.92	0.25	4588	5.10	2.92	324	333	SVTS10	0.016	0.04	2
RSV244	13.00	13.75	0.75	11106	4.11	3.17	977	985	SVTS10	0.010	0.04	8
RSV216 **	13.33	13.75	0.42	7196	4.76	2.93	2308	2314	SVTS10	0.004	0.04	5
RSV236	12.42	13.75	1.33	9734	2.03	1.90	258	267	SVTS20_1	0.003	0.04	8
R242*	12.67	13.42	0.75	13351	4.94	4.01	2310	2317	SVTS10	0.010	0.04	9
RSV220	13.67	14.17	0.50	10623	5.90	4.96	6674	6681	SVTS50_2	0.004	0.04	6
R230*	12.50	12.83	0.33	8744	7.36	4.26	3214	3220	SVTS30	0.009	0.04	6
RSV212	14.00	14.67	0.67	9922	4.11	3.08	7179	7177	TSR408	0.005	0.04	6
RSV202	12.75	13.25	0.50	6617	3.68	2.03	977	984	TWTS50	0.004	0.04	5
RSV210	12.17	13.17	1.00	12156	3.38	2.87	642	651	SVTS40	0.007	0.04	11
R205*	12.25	13.00	0.75	9517	3.52	2.98	585	594	SVTS40	0.008	0.04	1
RSV203	12.17	12.67	0.50	7461	4.14	1.66	73	63	SVTS40	0.009	0.04	7
RSV200 **	17.33	17.58	0.25	5688	6.32	4.19	14045	14039	TWTS50	0.005	0.04	5
RTW416	12.50	13.75	1.25	18065	4.01	2.18	359	368	WITS30	0.005	0.04	15
RTW420	12.67	13.58	0.91	12733	3.89	2.23	460	469	WITS30	0.005	0.04	10

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW414	12.17	13.25	1.08	10139	2.61	1.80	760	765	TSR408	0.007	0.04	8
RTW410 **	17.58	18.25	0.67	11703	4.85	4.18	13989	13986	TWTS50	0.005	0.04	8
RTW402	15.58	15.75	0.17	2375	3.88	6.92	16000	16007	Channel	0.001	0.035	1
RTW448	12.83	13.83	1.00	8794	2.44	1.96	152	161	WITS10	0.010	0.035	5
RD448	12.83	13.00	0.17	1591	2.60	1.51	40	30	WITS130	0.013	0.035	1
R446A	12.92	13.58	0.66	6777	2.85	2.40	211	220	WITS130	0.009	0.035	4
RTW446	13.50	13.92	0.42	6941	4.59	2.45	455	464	WITS20	0.009	0.04	4
RTW432	12.75	13.33	0.58	8990	4.31	2.83	734	743	TWTS30	0.006	0.04	7
RTW459	13.08	13.42	0.34	6625	5.41	2.77	384	393	TWTS20	0.013	0.035	2
RD380 **	13.50	13.67	0.17	1142	1.87	2.54	1954	1960	TWTS20	0.004	0.035	1
RTW462	13.67	13.83	0.16	6520	11.32	4.25	2018	2023	TWTS20	0.014	0.035	2
R450A	12.83	13.25	0.42	5936	3.93	3.20	538	546	WITS10	0.015	0.035	1
R450B	13.83	14.50	0.67	18811	7.80	4.42	2499	2504	WITS10	0.012	0.035	8
RD446A +	0.00	0.00	0.08	2942	9.81	0.18	0	0	WITS130	0.009	0.035	1
RTW450	14.42	14.75	0.33	7274	6.12	3.99	2604	2608	WITS10	0.009	0.035	4
RTW444	14.75	14.92	0.17	2739	4.48	3.85	2556	2563	WITS20	0.009	0.04	1
RTW460	13.00	13.17	0.17	4935	8.06	4.07	1152	1160	WITS10	0.017	0.035	2
RTW458	13.08	13.25	0.17	3227	5.27	4.00	1457	1464	WITS10	0.014	0.035	2
RTW456	13.25	13.42	0.17	4821	7.88	3.83	1461	1468	WITS10	0.012	0.035	2
RTW454	13.42	14.33	0.91	13093	4.00	2.76	509	517	WITS10	0.010	0.035	10
R452A	12.75	13.75	1.00	16523	4.59	3.33	675	682	WITS10	0.014	0.035	11
R452B	13.75	14.42	0.67	9296	3.85	3.23	1257	1264	WITS10	0.008	0.035	4
RD450	14.42	14.67	0.25	2017	2.24	1.81	120	129	WITS130	0.006	0.035	1
RTW452	14.50	15.00	0.50	8151	4.53	3.41	1415	1422	WITS20	0.010	0.04	6
R442*	14.92	15.50	0.58	9088	4.35	3.81	3623	3629	WITS20	0.007	0.04	6
RTW434	15.50	16.00	0.50	7363	4.09	3.97	3790	3798	TWTS30	0.005	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW436	12.25	13.17	0.92	13449	4.06	2.45	563	571	TWTS30	0.005	0.04	10
RTW429	12.33	13.17	0.84	3703	1.22	1.22	320	330	TSR429	0.001	0.04	2
RD454	13.42	13.58	0.16	3342	5.80	4.90	978	986	WITS90_2	0.014	0.035	1
R576A	12.83	13.42	0.59	8797	4.14	3.38	558	566	WITS10	0.017	0.035	6
R576B	13.33	15.25	1.92	18394	2.66	2.59	347	356	WITS10	0.011	0.035	16
RTW485	12.92	13.00	0.08	1831	6.36	2.87	1903	1909	TSR482	0.007	0.04	1
RTW484	13.00	13.67	0.67	10402	4.31	3.17	1959	1966	TSR482	0.009	0.04	7
R580B	12.50	12.92	0.42	8181	5.41	2.89	237	246	WITS10	0.020	0.035	5
R580A	12.75	13.83	1.08	21213	5.46	3.65	1804	1810	WITS10	0.009	0.035	14
RD580B	12.50	13.00	0.50	9430	5.24	3.62	200	209	WITS90_1	0.020	0.035	6
RWI578	13.08	13.67	0.59	12424	5.85	3.69	411	420	WITS90_1	0.013	0.035	8
RWI580	13.83	14.25	0.42	8541	5.65	4.11	2114	2121	WITS10	0.011	0.035	5
RD576B	13.33	14.25	0.92	13552	4.09	2.40	248	257	WITS10	0.012	0.035	9
RWI576	14.25	14.67	0.42	8726	5.77	3.24	1019	1027	WITS10	0.010	0.035	5
RTW482	14.67	15.17	0.50	7471	4.15	2.58	1001	1009	TSR482	0.008	0.04	6
RTW480	13.67	14.08	0.41	4817	3.26	3.40	2663	2669	TSR482	0.008	0.04	2
RTW478	14.08	14.67	0.59	5969	2.81	2.06	2551	2558	TSR478	0.001	0.04	3
RTW430	16.42	16.83	0.41	10141	6.87	4.17	4245	4252	WITS30	0.006	0.04	1
RTW418	16.92	17.50	0.58	7044	3.37	4.09	3962	3969	WITS30	0.006	0.04	1
RTW424	12.25	12.50	0.25	5625	6.25	3.24	1773	1781	WITS30	0.005	0.04	3
RTW422	17.58	19.17	1.59	22821	3.99	3.46	3863	3868	WITS30	0.004	0.04	17
RTW400	15.92	16.17	0.25	6826	7.58	11.48	17551	17558	Channel	0.004	0.035	2
RWI504	16.17	16.25	0.08	1494	5.19	7.09	17514	17521	Channel	0.001	0.035	1
RD576	14.25	14.50	0.25	4830	5.37	3.43	1331	1337	WITS10	0.010	0.035	3
RWI574	12.33	13.50	1.17	14010	3.33	1.90	118	127	WITS10	0.011	0.035	7
RWI572	12.50	13.25	0.75	23543	8.72	4.98	1567	1574	WITS90_1	0.012	0.035	12

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI570	12.83	13.25	0.42	12212	8.08	4.86	1160	1168	WITS90_1	0.014	0.035	4
RWI566	12.83	13.33	0.50	10390	5.77	3.52	379	388	WITS90_1	0.012	0.035	8
RWI564	13.17	13.67	0.50	9364	5.20	4.13	748	757	WITS90_1	0.012	0.035	3
R562*	13.33	14.00	0.67	14581	6.05	4.25	2344	2350	WITS40	0.011	0.035	8
R560A	13.00	14.00	1.00	16408	4.56	3.21	780	788	WITS10	0.012	0.035	9
RWI560	14.08	14.67	0.59	11699	5.51	4.34	5105	5110	WITS40	0.007	0.035	8
RD482 +	0.00	0.00	0.08	2439	8.13	0.19	0	0	WITS130	0.009	0.035	1
RWI582	12.42	13.00	0.58	5153	2.47	1.72	216	225	WITS10	0.005	0.035	2
RWI556	12.08	13.75	1.67	11635	1.94	0.94	25	15	WITS40	0.007	0.035	4
RWI554	14.67	14.75	0.08	4538	15.76	9.27	5155	5162	WITS50	0.014	0.035	2
RWI552 +	14.75	14.75	0.08	1732	5.77	5.16	5158	5163	WITS70	0.012	0.04	1
RWI584	12.42	12.67	0.25	1409	1.57	1.24	759	768	WITS70	0.001	0.04	1
RWI550	15.08	15.42	0.34	6201	5.07	4.42	4832	4837	WITS70	0.008	0.04	2
RWI548	12.33	13.25	0.92	13444	4.06	3.16	224	214	WITS90_2	0.012	0.035	7
RWI546	12.33	13.33	1.00	5296	1.47	3.02	440	449	WITS90_3	0.009	0.035	3
RWI544	12.50	13.33	0.83	9910	3.32	2.50	446	454	WITS40	0.008	0.035	5
RWI540	12.83	13.00	0.17	4350	7.11	4.74	781	789	WITS90_1	0.017	0.035	1
R538A	12.92	13.67	0.75	18226	6.75	5.06	1139	1148	WITS90_2	0.013	0.035	8
RWI538	13.58	14.25	0.67	15096	6.26	4.25	1643	1650	WITS90_3	0.008	0.035	9
RWI534	12.58	12.75	0.17	3889	6.35	3.08	379	387	WITS90_3	0.011	0.035	2
R530*	13.00	13.75	0.75	14751	5.46	3.78	1003	1010	WITS90_3	0.008	0.035	9
RD544	12.50	13.08	0.58	9401	4.50	3.05	993	1001	WITS40	0.008	0.035	6
RPI663	12.92	13.75	0.83	14316	4.79	4.39	304	313	PITS10_1	0.015	0.035	10
RPI660	13.50	13.75	0.25	5729	6.37	5.51	955	964	PITS10_1	0.013	0.035	1
RPI654 **	13.33	13.58	0.25	6847	7.61	5.95	2448	2454	PITS10_2	0.010	0.035	4
RPI651 **	13.42	13.75	0.33	5658	4.76	5.50	3384	3390	PITS10_2	0.007	0.035	3

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
R645A	13.08	13.42	0.34	8664	7.08	4.87	876	885	PITS10_2	0.012	0.035	5
RD654	13.33	13.83	0.50	11215	6.23	4.10	597	606	PITS10_2	0.010	0.035	6
RPI689	12.92	13.33	0.41	18798	12.74	10.49	6389	6394	WITS100	0.017	0.035	4
RPI687	13.25	13.42	0.17	10777	17.61	11.80	9861	9865	WITS100	0.017	0.035	3
RPI684	13.58	13.92	0.34	14047	11.48	9.91	9368	9372	WITS110_1	0.014	0.035	4
RPI681	13.83	14.50	0.67	19831	8.22	7.61	9000	9003	WITS110_2	0.011	0.035	7
RPI690 **	14.50	14.67	0.17	2826	4.62	4.21	6454	6459	WITS110_2	0.003	0.035	1
RD678	14.50	14.92	0.42	6108	4.04	3.55	2162	2170	WITS110_2	0.004	0.035	1
RWI542	16.08	16.25	0.17	2706	4.42	2.73	397	406	WITS90_3	0.007	0.035	1
RWI529	16.00	16.25	0.25	3670	4.08	2.32	407	416	WITS70	0.010	0.04	1
RWI516	15.42	16.17	0.75	11711	4.34	3.70	4939	4942	WITS70	0.005	0.04	6
RDCP07	16.08	16.58	0.50	6956	3.86	2.88	407	416	WITS120	0.008	0.035	2
RD529 +	0.00	0.00	0.08	4871	16.24	0.17	0	0	WITS130	0.008	0.035	2
RWI528	16.33	16.92	0.59	8240	3.88	2.11	417	425	WITS70	0.007	0.04	1
RDCPOT +	0.00	0.00	0.08	8638	28.79	0.15	0	0	WITS70	0.007	0.04	2
RWI527	12.50	12.92	0.42	5909	3.91	2.17	501	509	WITS70	0.007	0.04	3
R508*	16.25	16.92	0.67	12366	5.13	4.60	5173	5179	WITS130	0.005	0.035	7
R510A	12.58	13.75	1.17	17257	4.10	2.02	553	561	WITS70	0.005	0.04	8
RWI510	16.83	17.25	0.42	6492	4.29	3.47	4215	4221	WITS70	0.005	0.04	2
RWI502	16.33	16.42	0.09	1679	5.18	10.45	20084	20090	Channel	0.003	0.035	1
RDCP08	16.08	16.33	0.25	4229	4.70	3.24	408	417	WITS120	0.011	0.035	1
RWI526	16.08	16.92	0.84	11922	3.94	2.70	417	426	WITS120	0.007	0.035	6
RDCP09	16.08	17.00	0.92	14618	4.41	2.97	410	419	WITS120	0.009	0.035	8
RD527	12.50	13.33	0.83	7666	2.57	0.16	4	0	WITS130	0.007	0.035	2
RWI525	12.58	13.33	0.75	11015	4.08	3.39	1184	1192	WITS130	0.006	0.035	6
RD525	12.58	13.58	1.00	6496	1.80	1.44	63	53	WITS130	0.007	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI524	12.58	13.00	0.42	4526	2.99	2.78	577	586	WITS130	0.006	0.035	2
RWI506	13.17	13.42	0.25	5235	5.82	2.76	2134	2142	WITS70	0.004	0.04	3
RD508	16.92	17.17	0.25	5200	5.78	2.59	972	979	WITS70	0.007	0.04	2
RWI500	27.00	27.58	0.58	5659	2.71	4.36	2901	2910	Channel	0.001	0.035	3
RPI635	27.58	28.33	0.75	7557	2.80	4.36	2900	2909	Channel	0.001	0.035	6
RDCP11	16.08	16.33	0.25	6377	7.09	3.71	424	433	PITS10_2	0.009	0.035	5
RDCP12	16.08	16.42	0.34	6159	5.03	3.14	410	419	PITS30	0.009	0.035	2
RPI618	16.17	16.67	0.50	10443	5.80	3.09	399	408	PITS20	0.008	0.035	5
RDCP13	16.08	16.67	0.59	11034	5.20	3.10	420	429	PITS30	0.009	0.035	6
RD618	16.17	16.42	0.25	4541	5.05	3.39	450	459	PITS20	0.009	0.035	2
RPI615	16.42	16.75	0.33	5109	4.30	3.85	882	890	PITS20	0.008	0.035	2
RPI612	12.67	13.00	0.33	5754	4.84	2.71	327	336	PITS20	0.006	0.035	3
RDCP14	16.08	17.25	1.17	20386	4.84	2.95	362	371	PITS30	0.009	0.035	12
RPI609	12.75	12.92	0.17	4513	7.37	6.04	1171	1180	PITS40	0.006	0.035	2
RD612	12.67	17.33	4.66	11125	0.66	3.66	960	968	PITS20	0.007	0.035	8
RPI621	13.33	13.42	0.09	2775	8.56	3.73	1159	1167	TSR621	0.008	0.035	1
RDCP10	16.08	16.50	0.42	6701	4.43	2.87	420	429	WITS120	0.008	0.035	4
RPI628	12.33	13.08	0.75	14427	5.34	3.15	507	516	PITS20	0.007	0.035	6
R624A	12.83	13.83	1.00	11809	3.28	2.84	1528	1536	PDTS40_1	0.004	0.035	6
RD524	12.58	12.83	0.25	2235	2.48	0.10	3	0	WITS130	0.003	0.035	1
RPI639	12.75	13.58	0.83	5380	1.80	1.66	115	124	WITS130	0.005	0.035	2
RPI636	12.50	12.58	0.08	728	2.53	3.36	393	402	WITS130	0.014	0.035	1
RPI624 **	13.83	14.17	0.34	5060	4.13	3.35	1848	1856	TSR621	0.004	0.035	3
RPI633	24.75	25.42	0.67	5834	2.42	4.73	3867	3876	Channel	0.001	0.035	4
RDCP15	14.00	14.42	0.42	9602	6.35	2.90	248	257	PITS30	0.011	0.035	6
R606A	12.50	17.92	5.42	12583	0.64	2.49	166	175	PDTS30	0.008	0.035	7

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPI606	12.42	12.67	0.25	2654	2.95	2.32	578	586	TSR606	0.006	0.035	1
RD606A	12.50	12.83	0.33	7507	6.32	2.31	131	140	PITS30	0.009	0.035	6
RPI604	12.67	12.92	0.25	7442	8.27	2.78	312	321	PDTS30	0.007	0.035	4
RD600A	12.58	13.33	0.75	4775	1.77	1.86	1115	1123	TSBEAR	0.001	0.035	2
RPI603	13.17	13.42	0.25	3427	3.81	3.18	2237	2244	PDTS40_1	0.004	0.035	1
RPI600	24.75	25.25	0.50	4937	2.74	4.89	4373	4382	Channel	0.001	0.035	2
RDCP16	14.00	14.50	0.50	10754	5.97	4.34	907	916	PDTS30	0.011	0.035	8
RDCP17	14.00	14.42	0.42	10400	6.88	3.31	303	312	PDTS30	0.012	0.035	5
RPD740	14.33	14.67	0.34	5434	4.44	3.82	1269	1278	PDTS30	0.006	0.035	5
R726B	13.25	14.75	1.50	4094	0.76	4.25	1292	1301	PDTS30	0.008	0.035	2
RDCP18	14.00	14.58	0.58	14927	7.15	3.16	311	320	PDTS30	0.010	0.035	8
RPD736	14.17	14.33	0.16	1894	3.29	2.75	449	458	PDTS30	0.005	0.035	1
RDCP19	14.00	14.25	0.25	5902	6.56	4.89	955	963	PDTS30	0.015	0.035	4
RPD760	12.75	12.92	0.17	5149	8.41	3.31	364	373	PDTS30	0.010	0.035	2
RPD732	13.83	14.42	0.59	10623	5.00	3.77	1179	1187	PDTS30	0.006	0.035	6
R726A	14.25	14.42	0.17	3986	6.51	4.34	1805	1814	PDTS30	0.007	0.035	2
R726*	14.50	15.17	0.67	4179	1.73	4.55	2943	2949	PDTS30	0.006	0.035	2
RPD726	15.08	15.42	0.34	4959	4.05	3.24	2405	2411	PDTS40_1	0.004	0.035	2
RD744 +	0.00	0.00	0.08	3177	10.59	0.15	0	0	TSR606	0.006	0.035	1
RPD720	15.00	15.08	0.08	1840	6.39	12.11	5910	5918	Channel	0.010	0.035	1
RD716	15.08	15.25	0.17	4300	7.03	2.98	584	593	PDTS40_1	0.009	0.035	2
R700*	15.25	15.92	0.67	5757	2.39	5.39	6233	6242	Channel	0.001	0.035	2
RPD748	12.42	12.75	0.33	6476	5.45	4.57	440	449	PDTS40_2	0.015	0.035	3
RPD756	13.17	13.50	0.33	8775	7.39	5.89	1459	1467	PDTS40_2	0.013	0.035	4
R708*	13.50	13.92	0.42	10484	6.93	4.98	1504	1513	PDTS40_2	0.008	0.035	6
R712A	12.92	13.25	0.33	6448	5.43	3.74	389	398	PDTS40_2	0.009	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPD708	12.92	13.08	0.16	2780	4.83	3.69	2672	2679	PDTS40_1	0.006	0.035	1
RPD704	13.17	13.42	0.25	5924	6.58	3.70	2930	2937	PDTS40_1	0.006	0.035	4
RD800 +	0.00	0.00	0.08	5888	19.63	0.15	0	0	PDTS40_1	0.006	0.035	2
R810*	15.50	15.92	0.42	10685	7.07	4.71	7085	7086	PDTS40_1	0.006	0.035	8
RAF803	12.50	12.75	0.25	5287	5.87	4.34	1744	1753	TSAF10	0.002	0.035	3
RAF805	12.58	12.92	0.34	6821	5.57	2.44	506	515	PDTS40_1	0.006	0.035	6
RAF807	12.67	12.75	0.08	2485	8.63	6.28	2496	2505	TSAF10	0.004	0.035	1
RAF810	15.83	16.08	0.25	8372	9.30	5.44	7214	7218	PDTS40_1	0.008	0.035	5
RAF854	12.08	12.17	0.09	2113	6.52	4.21	527	537	TSAF10	0.005	0.035	1
RAF852 +	12.17	12.17	0.08	1378	4.59	4.65	783	792	TSAF10	0.004	0.035	1
RAF864	12.25	12.75	0.50	4666	2.59	1.58	50	40	TSAF20	0.003	0.035	1
RAF862	12.00	12.08	0.08	2136	7.42	3.55	294	304	TSAF20	0.005	0.035	1
RAF866	12.17	12.50	0.33	6743	5.68	3.81	406	416	TSAF20	0.004	0.035	1
RSV258	12.42	12.58	0.16	2155	3.74	3.22	313	321	TSR248	0.018	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation
** Modified Typical X-Section
x Modified Time To Peak Used

D.3.4 NSTEP Check Data: 100-yr 6-hr Existing Conditions

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWT140	5.17	5.42	0.25	13053	14.50	6.45	1849	1857	WTTS20_1	0.019	0.035	3
RWT130	5.25	5.83	0.58	5750	2.75	4.18	2498	2507	Channel	0.001	0.035	5
RWT160	4.58	6.25	1.67	18961	3.15	2.55	501	509	WTTS10_1	0.012	0.035	12
R150A	5.08	5.25	0.17	9557	15.62	9.29	2582	2590	WTTS20_2	0.021	0.035	3
RWT150	5.17	5.58	0.41	16082	10.90	6.22	2752	2758	WTTS20_1	0.013	0.035	5
RWT120	5.67	6.17	0.50	6168	3.43	5.13	5198	5206	Channel	0.001	0.035	7
RWT110	6.17	6.83	0.66	7640	3.22	5.06	4924	4932	Channel	0.001	0.035	5
RWT100	6.75	7.17	0.42	4778	3.16	4.97	4614	4623	Channel	0.001	0.035	1
RTW406	4.08	8.42	4.34	14969	0.96	0.58	40	31	TSR408	0.008	0.04	6
RTW408	4.83	7.75	2.92	16567	1.58	1.31	298	306	TSR408	0.007	0.04	10
RTW404	7.17	7.50	0.33	2936	2.47	4.93	4499	4508	Channel	0.001	0.035	2
RIW371	4.08	6.50	2.42	11583	1.33	0.40	15	5	TSR371	0.009	0.04	15
RIW366	4.58	5.00	0.42	9657	6.39	4.89	957	966	IWTS30_2	0.007	0.04	4
RIW377	4.50	5.25	0.75	6588	2.44	1.06	98	89	TSR371	0.010	0.04	6
RD371	4.08	4.33	0.25	1409	1.57	0.71	40	30	WITS130	0.001	0.035	1
RIW374	4.25	5.92	1.67	20437	3.40	1.54	404	411	TSR371	0.008	0.04	15
RIW386	4.58	5.42	0.84	10311	3.41	2.68	301	310	IWTS20_1	0.008	0.035	6
RIW382	4.33	4.83	0.50	4964	2.76	1.56	253	260	TSR371	0.012	0.04	3
RD382A	4.33	4.42	0.09	1172	3.62	2.17	196	205	WITS130	0.007	0.035	1
RIW384	4.33	4.67	0.34	4694	3.84	1.67	310	317	TSR371	0.012	0.04	3
RIW381	4.50	4.83	0.33	4964	4.18	1.80	574	582	TSR371	0.010	0.04	3
R359*	4.83	5.17	0.34	9280	7.58	5.48	937	946	IWTS30_2	0.010	0.04	4
RIW359 **	5.00	5.33	0.33	13031	10.97	7.19	3233	3242	IWTS30_2	0.006	0.04	4
RIW389	4.42	5.75	1.33	11459	2.39	1.24	102	111	TSR371	0.012	0.04	6
RIW394	5.08	5.25	0.17	7697	12.58	7.79	2613	2620	IWTS10_1	0.013	0.035	2
R390A	5.25	5.42	0.17	8577	14.01	8.04	2925	2933	IWTS10_1	0.013	0.035	2

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW390	5.50	5.75	0.25	11626	12.92	6.34	2969	2975	IWTS20_1	0.010	0.035	3
RIW388	5.67	5.92	0.25	7726	8.58	5.84	3450	3457	IWTS20_2	0.009	0.04	2
RIW357 **	5.92	6.42	0.50	16693	9.27	6.08	2608	2617	IWTS30_1	0.008	0.04	9
RIW353	5.50	5.75	0.25	7496	8.33	4.13	5328	5334	IWTS40_1	0.005	0.04	2
RIW312	4.75	5.83	1.08	8292	2.13	3.25	238	247	TSR375	0.010	0.04	1
RD312	4.75	4.92	0.17	1034	1.69	2.34	223	232	WITS130	0.008	0.035	1
RIW365	4.83	5.42	0.59	7351	3.46	3.73	298	308	IWTS30_1	0.009	0.04	5
RD365	4.83	5.00	0.17	1700	2.78	2.76	268	277	WITS130	0.011	0.035	2
RIW369	5.00	5.33	0.33	6797	5.72	3.89	463	472	TSR375	0.009	0.04	4
RD357	5.92	6.00	0.08	2791	9.69	4.71	930	939	IWTS30_1	0.008	0.04	2
RIW363	5.50	6.08	0.58	11127	5.33	5.05	1281	1290	IWTS30_1	0.008	0.04	4
RD369	4.92	5.17	0.25	1927	2.14	2.28	344	353	WITS130	0.005	0.035	1
RIW368	5.08	5.67	0.59	11648	5.48	4.05	438	447	TSR375	0.010	0.04	6
RIW360	4.33	4.42	0.09	2593	8.00	2.71	751	758	TWTS20	0.008	0.035	1
RIW397	4.92	5.42	0.50	21294	11.83	7.59	3662	3667	TWTS10	0.021	0.035	8
RIW395	5.25	5.50	0.25	13324	14.80	8.82	7558	7563	TWTS10	0.017	0.035	3
RIW387 +	4.67	4.67	0.08	1005	3.35	3.87	1332	1338	TWTS20	0.014	0.035	1
RIW396	5.42	5.58	0.16	6512	11.31	8.42	7911	7915	TWTS10	0.014	0.035	1
RIW380 **	5.58	6.67	1.09	16914	4.31	5.41	5586	5591	TWTS20	0.013	0.035	11
RIW370 **	6.58	7.17	0.59	7248	3.41	4.79	5504	5505	TWTS20	0.010	0.035	3
RIW349	7.17	7.25	0.08	4331	15.04	4.57	2088	2092	TWTS20	0.016	0.035	1
RD349 **	7.17	7.42	0.25	4244	4.72	4.47	3318	3323	TWTS20	0.011	0.035	1
RIW356 **	7.33	7.42	0.09	2643	8.16	3.07	5405	5404	TSR371	0.009	0.04	1
RIW354 **	7.42	7.75	0.33	4523	3.81	2.86	5317	5317	TSR371	0.007	0.04	2
RIW372	4.33	5.50	1.17	15367	3.65	2.81	153	162	TSR375	0.010	0.04	9
RD372	4.33	4.50	0.17	1828	2.99	1.68	203	212	WITS130	0.003	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW375	4.92	5.58	0.66	13330	5.61	3.92	413	422	TSR375	0.010	0.04	8
RIW364 **	7.67	8.33	0.66	10402	4.38	2.89	5302	5298	TSR371	0.007	0.04	7
RD363	5.50	5.75	0.25	3820	4.24	4.51	598	607	IWTS30_1	0.009	0.04	1
RIW351	5.42	8.25	2.83	24311	2.39	1.83	80	70	IWTS30_2	0.008	0.04	10
RIW346	8.25	8.50	0.25	3706	4.12	4.32	5250	5255	TWTS30	0.005	0.04	2
RIW338	8.50	8.92	0.42	7227	4.78	4.60	5177	5184	TWTS30	0.006	0.04	5
RIW326	4.33	4.92	0.59	8066	3.80	2.23	355	364	TWTS30	0.006	0.04	5
RIW334	9.00	9.83	0.83	21501	7.20	4.96	5042	5047	TWTS40	0.007	0.04	12
RD351	5.42	5.75	0.33	6586	5.54	4.16	595	604	IWTS30_1	0.008	0.04	3
RIW361 **	5.92	6.58	0.66	17152	7.22	5.18	1870	1878	IWTS30_1	0.006	0.04	12
R350*	5.92	6.25	0.33	8310	6.99	4.66	6886	6888	IWTS40_1	0.006	0.04	3
RIW330	6.17	6.33	0.16	2771	4.81	3.85	6885	6890	IWTS40_2	0.005	0.04	1
RIW322	6.33	7.00	0.67	12886	5.34	3.98	7151	7155	IWTS40_2	0.005	0.04	12
RIW318	4.67	6.33	1.66	17570	2.94	2.37	415	424	TSR294	0.005	0.04	15
RIW310	4.92	5.00	0.08	860	2.99	1.67	880	889	IWTS50	0.002	0.04	1
RIW314 **	7.42	8.50	1.08	20068	5.16	3.94	6625	6631	IWTS50	0.005	0.04	15
RIW300	8.50	8.83	0.33	6125	5.16	3.33	6532	6536	TWTS50	0.004	0.04	3
RIW302	9.33	9.67	0.34	5720	4.67	3.73	9794	9793	TWTS50	0.004	0.04	3
R264A	5.08	5.50	0.42	4042	2.67	2.26	1691	1699	TSR264A	0.003	0.04	1
RSV264	5.25	5.75	0.50	4870	2.71	2.46	2353	2361	TSR264A	0.003	0.04	1
RSV298	5.00	6.25	1.25	15129	3.36	2.80	591	600	TSR294	0.006	0.04	14
RSV286	4.75	5.00	0.25	3544	3.94	3.41	1299	1307	TSR294	0.006	0.04	1
RSV284	4.92	5.58	0.66	12013	5.06	3.44	1213	1221	TSR294	0.006	0.04	4
RSV290	4.58	5.67	1.09	13500	3.44	2.79	543	552	TSR294	0.006	0.04	5
RSV272	5.58	5.67	0.09	1628	5.02	4.17	1949	1957	SVTS50_1	0.006	0.04	1
RSV294	5.00	5.75	0.75	14316	5.30	3.78	1815	1823	TSR294	0.006	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RSV276 **	5.67	5.75	0.08	1016	3.53	4.29	3729	3736	SVTS50_1	0.004	0.04	1
RSV280 **	5.83	6.08	0.25	6288	6.99	3.98	4153	4160	SVTS50_1	0.003	0.04	3
RSV268	4.67	4.92	0.25	2946	3.27	2.21	1363	1371	SVTS50_1	0.001	0.04	1
RSV260 **	6.92	7.17	0.25	6946	7.72	4.73	4358	4366	SVTS50_1	0.005	0.04	5
RSV252	4.33	5.25	0.92	9744	2.94	1.64	95	85	SVTS10	0.009	0.04	5
RSV254	4.25	5.25	1.00	10928	3.04	1.52	71	61	SVTS10	0.010	0.04	6
RSV219	4.50	5.00	0.50	5058	2.81	2.30	903	912	SVTS10	0.004	0.04	3
RSV251	4.33	5.33	1.00	12592	3.50	2.15	196	205	SVTS10	0.010	0.04	8
RSV250	4.33	5.33	1.00	11765	3.27	1.72	94	85	SVTS10	0.011	0.04	8
RSV218 **	4.83	5.25	0.42	4698	3.11	2.59	1634	1642	SVTS10	0.004	0.04	2
RSV248	4.67	5.17	0.50	7772	4.32	3.20	423	432	TSR248	0.014	0.035	3
RD248	4.67	5.00	0.33	4588	3.86	3.10	407	416	SVTS10	0.016	0.04	2
RSV244	5.08	5.75	0.67	11106	4.60	3.34	1194	1201	SVTS10	0.010	0.04	8
RSV216 **	5.33	5.83	0.50	7196	4.00	3.01	2571	2577	SVTS10	0.004	0.04	5
RSV236	4.33	5.58	1.25	9734	2.16	2.09	386	395	SVTS20_1	0.003	0.04	8
R242* **	4.75	5.33	0.58	13351	6.39	4.08	2472	2478	SVTS10	0.010	0.04	9
RSV220 **	5.92	6.42	0.50	10623	5.90	4.91	6369	6374	SVTS50_2	0.004	0.04	6
R230*	4.50	4.92	0.42	8744	5.78	4.23	3153	3158	SVTS30	0.009	0.04	6
RSV212 **	6.08	6.67	0.59	9922	4.67	3.02	6708	6707	TSR408	0.005	0.04	6
RSV202	4.75	5.17	0.42	6617	4.38	2.17	1237	1245	TWTS50	0.004	0.04	5
RSV210	4.17	5.08	0.91	12156	3.71	3.12	897	905	SVTS40	0.007	0.04	11
R205*	4.50	5.00	0.50	9517	5.29	3.19	760	768	SVTS40	0.008	0.04	1
RSV203	4.08	4.67	0.59	7461	3.51	1.98	111	120	SVTS40	0.009	0.04	7
RSV200 **	9.50	9.83	0.33	5688	4.79	4.01	11835	11832	TWTS50	0.005	0.04	5
RTW416	4.42	5.58	1.16	18065	4.33	2.40	532	541	WITS30	0.005	0.04	15
RTW420	4.67	5.42	0.75	12733	4.72	2.43	647	656	WITS30	0.005	0.04	10

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW414	4.17	5.17	1.00	10139	2.82	1.99	1019	1026	TSR408	0.007	0.04	8
RTW410 **	9.75	10.42	0.67	11703	4.85	3.98	11555	11551	TWTS50	0.005	0.04	8
RTW402	10.33	10.42	0.09	2375	7.33	6.25	10817	10826	Channel	0.001	0.035	1
RTW448	4.75	5.75	1.00	8794	2.44	1.96	155	164	WITS10	0.010	0.035	5
RD448	4.75	4.92	0.17	1591	2.60	2.36	118	127	WITS130	0.013	0.035	1
R446A	4.75	5.33	0.58	6777	3.25	2.76	356	365	WITS130	0.009	0.035	4
RTW446	5.25	5.67	0.42	6941	4.59	2.62	603	612	WITS20	0.009	0.04	4
RTW432	4.83	5.42	0.59	8990	4.23	3.02	925	934	TWTS30	0.006	0.04	7
RTW459	5.17	5.33	0.16	6625	11.50	3.00	524	532	TWTS20	0.013	0.035	3
RD380 **	5.58	5.75	0.17	1142	1.87	2.55	1967	1973	TWTS20	0.004	0.035	1
RTW462	5.67	6.00	0.33	6520	5.49	4.55	2659	2663	TWTS20	0.014	0.035	2
R450A	4.83	5.08	0.25	5936	6.60	3.54	796	803	WITS10	0.015	0.035	2
R450B	5.92	6.58	0.66	18811	7.92	4.63	2994	2999	WITS10	0.012	0.035	8
RD446A	4.75	4.92	0.17	2942	4.81	0.18	7	0	WITS130	0.009	0.035	1
RTW450	6.50	6.83	0.33	7274	6.12	4.10	2904	2910	WITS10	0.009	0.035	3
RTW444	6.83	6.92	0.09	2739	8.45	3.96	2877	2883	WITS20	0.009	0.04	1
RTW460	4.83	5.25	0.42	4935	3.26	4.11	1201	1207	WITS10	0.017	0.035	2
RTW458	5.08	5.25	0.17	3227	5.27	4.14	1670	1676	WITS10	0.014	0.035	2
RTW456	5.25	5.42	0.17	4821	7.88	3.99	1701	1707	WITS10	0.012	0.035	2
RTW454	5.42	6.25	0.83	13093	4.38	2.90	611	620	WITS10	0.010	0.035	10
R452A	4.75	5.58	0.83	16523	5.53	3.59	907	914	WITS10	0.014	0.035	11
R452B	5.92	6.33	0.41	9296	6.30	3.42	1578	1584	WITS10	0.008	0.035	4
RD450	6.50	6.67	0.17	2017	3.30	2.09	206	215	WITS130	0.006	0.035	1
RTW452	6.42	6.92	0.50	8151	4.53	3.62	1796	1802	WITS20	0.010	0.04	6
R442*	6.92	7.50	0.58	9088	4.35	3.89	3934	3941	WITS20	0.007	0.04	6
RTW434	7.50	7.92	0.42	7363	4.87	4.02	3981	3989	TWTS30	0.005	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW436	4.25	5.17	0.92	13449	4.06	2.68	775	784	TWTS30	0.005	0.04	10
RTW429	4.33	5.00	0.67	3703	1.54	1.34	450	459	TSR429	0.001	0.04	2
RD454	5.42	5.58	0.16	3342	5.80	5.09	1139	1147	WITS90_2	0.014	0.035	1
R576A	4.83	5.33	0.50	8797	4.89	3.66	755	763	WITS10	0.017	0.035	6
R576B	5.25	6.67	1.42	18394	3.60	2.73	420	429	WITS10	0.011	0.035	16
RTW485	5.08	5.25	0.17	1831	2.99	2.97	2168	2174	TSR482	0.007	0.04	1
RTW484	5.17	5.92	0.75	10402	3.85	3.27	2206	2211	TSR482	0.009	0.04	7
R580B	4.42	4.92	0.50	8181	4.55	3.17	336	344	WITS10	0.020	0.035	5
R580A	4.83	5.83	1.00	21213	5.89	3.81	2131	2137	WITS10	0.009	0.035	14
RD580B	4.42	4.92	0.50	9430	5.24	3.89	288	279	WITS90_1	0.020	0.035	6
RWI578	5.00	5.50	0.50	12424	6.90	4.01	576	585	WITS90_1	0.013	0.035	8
RWI580	5.83	6.17	0.34	8541	6.98	4.24	2408	2414	WITS10	0.011	0.035	5
RD576B	5.25	6.50	1.25	13552	3.01	2.54	304	312	WITS10	0.012	0.035	9
RWI576	6.25	6.67	0.42	8726	5.77	3.62	1562	1569	WITS10	0.010	0.035	5
RTW482	6.58	7.00	0.42	7471	4.94	2.91	1597	1604	TSR482	0.008	0.04	6
RTW480	5.83	6.25	0.42	4817	3.19	3.50	2955	2961	TSR482	0.008	0.04	2
RTW478	6.25	6.92	0.67	5969	2.47	2.12	2858	2866	TSR478	0.001	0.04	3
RTW430	8.08	8.58	0.50	10141	5.63	4.22	4487	4492	WITS30	0.006	0.04	1
RTW418	8.58	9.00	0.42	7044	4.66	4.16	4209	4215	WITS30	0.006	0.04	1
RTW424	4.25	4.50	0.25	5625	6.25	3.36	2063	2071	WITS30	0.005	0.04	3
RTW422	9.00	10.58	1.58	22821	4.01	3.43	3741	3747	WITS30	0.004	0.04	17
RTW400	10.50	10.75	0.25	6826	7.58	10.20	11309	11316	Channel	0.004	0.035	2
RWI504	10.75	10.83	0.08	1494	5.19	6.31	11242	11250	Channel	0.001	0.035	1
RD576	6.25	6.50	0.25	4830	5.37	3.21	1021	1029	WITS10	0.010	0.035	2
RWI574	4.33	5.33	1.00	14010	3.89	2.13	180	189	WITS10	0.011	0.035	7
RWI572	4.50	5.25	0.75	23543	8.72	5.11	1732	1740	WITS90_1	0.012	0.035	8

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI570	4.83	5.17	0.34	12212	9.98	5.13	1439	1446	WITS90_1	0.014	0.035	5
RWI566	4.83	5.25	0.42	10390	6.87	3.80	519	528	WITS90_1	0.012	0.035	8
RWI564	5.25	5.58	0.33	9364	7.88	4.40	970	978	WITS90_1	0.012	0.035	4
R562*	5.33	6.00	0.67	14581	6.05	4.43	2748	2754	WITS40	0.011	0.035	8
R560A	5.08	5.92	0.84	16408	5.43	3.42	994	1000	WITS10	0.012	0.035	9
RWI560	5.92	6.50	0.58	11699	5.60	4.37	5269	5274	WITS40	0.007	0.035	8
RD482 +	0.00	0.00	0.08	2439	8.13	0.19	0	0	WITS130	0.009	0.035	1
RWI582	4.33	4.83	0.50	5153	2.86	1.91	321	330	WITS10	0.005	0.035	2
RWI556	4.08	5.58	1.50	11635	2.15	1.11	36	26	WITS40	0.007	0.035	4
RWI554	6.50	6.58	0.08	4538	15.76	9.32	5262	5269	WITS50	0.014	0.035	2
RWI552	6.58	6.67	0.09	1732	5.35	5.18	5245	5249	WITS70	0.012	0.04	1
RWI584	4.50	4.67	0.17	1409	2.30	1.33	983	992	WITS70	0.001	0.04	1
RWI550	7.00	7.33	0.33	6201	5.22	4.42	4827	4833	WITS70	0.008	0.04	2
RWI548	4.33	5.17	0.84	13444	4.45	3.53	324	333	WITS90_2	0.012	0.035	7
RWI546	5.00	5.17	0.17	5296	8.65	3.37	617	625	WITS90_3	0.009	0.035	3
RWI544	4.58	5.33	0.75	9910	3.67	2.63	545	554	WITS40	0.008	0.035	5
RWI540	4.83	5.00	0.17	4350	7.11	5.07	1023	1030	WITS90_1	0.017	0.035	1
R538A	4.92	5.58	0.66	18226	7.67	5.38	1460	1467	WITS90_2	0.013	0.035	8
RWI538	5.50	6.17	0.67	15096	6.26	4.52	2036	2044	WITS90_3	0.008	0.035	9
RWI534	4.50	4.75	0.25	3889	4.32	3.47	544	553	WITS90_3	0.011	0.035	2
R530*	4.92	5.58	0.66	14751	6.21	4.07	1279	1286	WITS90_3	0.008	0.035	9
RD544	4.58	5.17	0.59	9401	4.43	3.19	1182	1190	WITS40	0.008	0.035	6
RPI663	4.83	5.58	0.75	14316	5.30	4.78	428	437	PITS10_1	0.015	0.035	10
RPI660	5.42	5.58	0.16	5729	9.95	5.87	1231	1240	PITS10_1	0.013	0.035	1
RPI654 **	5.33	5.67	0.34	6847	5.59	6.17	2828	2834	PITS10_2	0.010	0.035	4
RPI651 **	5.50	5.75	0.25	5658	6.29	5.67	3828	3836	PITS10_2	0.007	0.035	3

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
R645A	5.08	5.42	0.34	8664	7.08	5.18	1127	1135	PITS10_2	0.012	0.035	5
RD654	5.33	5.92	0.59	11215	5.28	4.25	692	701	PITS10_2	0.010	0.035	6
RPI689	5.00	5.33	0.33	18798	15.82	10.48	6362	6366	WITS100	0.017	0.035	5
RPI687	5.33	5.50	0.17	10777	17.61	11.55	9166	9171	WITS100	0.017	0.035	2
RPI684	5.67	5.92	0.25	14047	15.61	9.77	8893	8899	WITS110_1	0.014	0.035	4
RPI681 **	5.92	6.50	0.58	19831	9.50	7.54	8711	8715	WITS110_2	0.011	0.035	7
RPI690 **	6.50	6.67	0.17	2826	4.62	4.21	6474	6480	WITS110_2	0.003	0.035	1
RD678	6.50	6.92	0.42	6108	4.04	3.54	2122	2130	WITS110_2	0.004	0.035	1
RWI542	8.33	8.50	0.17	2706	4.42	2.71	388	396	WITS90_3	0.007	0.035	1
RWI529	7.67	7.75	0.08	3670	12.74	2.39	447	455	WITS70	0.010	0.04	1
RWI516	7.33	8.42	1.09	11711	2.98	3.63	4621	4625	WITS70	0.005	0.04	6
RDCP07	8.33	8.83	0.50	6956	3.86	2.86	396	405	WITS120	0.008	0.035	2
RD529	7.67	7.75	0.08	4871	16.91	0.17	0	0	WITS130	0.008	0.035	1
RWI528	7.83	8.25	0.42	8240	5.45	2.14	437	446	WITS70	0.007	0.04	1
RDCPOT +	0.00	0.00	0.08	8638	28.79	0.15	0	0	WITS70	0.007	0.04	2
RWI527	4.50	4.83	0.33	5909	4.97	2.35	651	659	WITS70	0.007	0.04	3
R508* **	8.42	8.92	0.50	12366	6.87	4.48	4673	4677	WITS130	0.005	0.035	7
R510A	4.58	5.67	1.09	17257	4.40	2.21	751	759	WITS70	0.005	0.04	8
RWI510	8.83	9.08	0.25	6492	7.21	3.39	3863	3870	WITS70	0.005	0.04	2
RWI502	10.67	10.75	0.08	1679	5.83	9.17	12258	12265	Channel	0.003	0.035	1
RDCP08	8.33	8.58	0.25	4229	4.70	3.22	396	405	WITS120	0.011	0.035	1
RWI526	7.67	8.58	0.91	11922	3.64	2.72	429	438	WITS120	0.007	0.035	6
RDCP09	8.33	9.25	0.92	14618	4.41	2.95	399	408	WITS120	0.009	0.035	8
RD527	4.50	5.08	0.58	7666	3.67	1.07	31	21	WITS130	0.007	0.035	2
RWI525	4.67	5.42	0.75	11015	4.08	3.24	988	997	WITS130	0.006	0.035	6
RD525	4.67	5.50	0.83	6496	2.17	1.32	50	40	WITS130	0.007	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI524	4.58	4.92	0.34	4526	3.70	2.94	715	724	WITS130	0.006	0.035	2
RWI506	5.25	5.50	0.25	5235	5.82	2.66	1886	1893	WITS70	0.004	0.04	3
RD508	8.92	9.17	0.25	5200	5.78	2.52	875	883	WITS70	0.007	0.04	2
RWI500	18.92	19.50	0.58	5659	2.71	3.62	1521	1530	Channel	0.001	0.035	3
RPI635	19.50	20.33	0.83	7557	2.53	3.62	1518	1527	Channel	0.001	0.035	6
RDCP11	8.33	8.67	0.34	6377	5.21	3.70	416	425	PITS10_2	0.009	0.035	5
RDCP12	8.33	8.67	0.34	6159	5.03	3.12	399	408	PITS30	0.009	0.035	2
RPI618	7.83	8.33	0.50	10443	5.80	3.11	408	417	PITS20	0.008	0.035	5
RDCP13	8.33	9.00	0.67	11034	4.57	3.08	409	418	PITS30	0.009	0.035	6
RD618	7.83	8.00	0.17	4541	7.42	3.41	462	471	PITS20	0.009	0.035	2
RPI615	8.08	8.42	0.34	5109	4.17	3.87	898	907	PITS20	0.008	0.035	2
RPI612	8.58	8.83	0.25	5754	6.39	2.70	320	329	PITS20	0.006	0.035	3
RDCP14	8.33	9.50	1.17	20386	4.84	2.93	352	361	PITS30	0.009	0.035	12
RPI609	4.83	4.92	0.09	4513	13.93	5.93	1096	1105	PITS40	0.006	0.035	2
RD612	8.58	9.25	0.67	11125	4.61	3.66	958	967	PITS20	0.007	0.035	8
RPI621	5.25	5.42	0.17	2775	4.53	3.59	998	1007	TSR621	0.008	0.035	1
RDCP10	8.33	8.75	0.42	6701	4.43	2.85	409	418	WITS120	0.008	0.035	4
RPI628	4.33	8.67	4.34	14427	0.92	3.09	468	477	PITS20	0.007	0.035	6
R624A	5.00	5.92	0.92	11809	3.57	2.75	1342	1349	PDTS40_1	0.004	0.035	6
RD524	4.58	4.83	0.25	2235	2.48	0.53	16	6	WITS130	0.003	0.035	1
RPI639	4.67	5.33	0.66	5380	2.26	1.93	203	212	WITS130	0.005	0.035	2
RPI636 +	4.50	4.50	0.08	728	2.43	3.66	544	553	WITS130	0.014	0.035	1
RPI624 **	5.92	6.25	0.33	5060	4.26	3.23	1595	1603	TSR621	0.004	0.035	3
RPI633	14.25	15.00	0.75	5834	2.16	4.02	2169	2178	Channel	0.001	0.035	4
RDCP15	6.08	6.50	0.42	9602	6.35	2.79	213	222	PITS30	0.011	0.035	6
R606A	4.50	10.17	5.67	12583	0.62	2.59	192	201	PDTS30	0.008	0.035	7

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPI606	4.50	4.83	0.33	2654	2.23	2.41	668	677	TSR606	0.006	0.035	1
RD606A	4.50	4.83	0.33	7507	6.32	2.35	142	151	PITS30	0.009	0.035	6
RPI604	4.58	4.92	0.34	7442	6.08	2.98	414	423	PDTS30	0.007	0.035	4
RD600A	4.75	5.33	0.58	4775	2.29	1.83	1047	1056	TSBEAR	0.001	0.035	2
RPI603	5.25	5.42	0.17	3427	5.60	3.11	2034	2042	PDTS40_1	0.004	0.035	1
RPI600	13.17	13.92	0.75	4937	1.83	4.22	2572	2581	Channel	0.001	0.035	2
RDCP16	6.08	6.50	0.42	10754	7.11	4.22	814	822	PDTS30	0.011	0.035	8
RDCP17	6.08	6.50	0.42	10400	6.88	3.21	271	280	PDTS30	0.012	0.035	4
RPD740	9.42	9.67	0.25	5434	6.04	3.80	1248	1256	PDTS30	0.006	0.035	5
R726B	9.67	9.92	0.25	4094	4.55	4.19	1227	1235	PDTS30	0.008	0.035	2
RDCP18	6.08	6.67	0.59	14927	7.03	3.08	279	288	PDTS30	0.010	0.035	7
RPD736	6.17	6.25	0.08	1894	6.58	2.73	439	448	PDTS30	0.005	0.035	1
RDCP19	6.08	6.33	0.25	5902	6.56	4.76	859	868	PDTS30	0.015	0.035	4
RPD760	4.83	5.00	0.17	5149	8.41	3.38	396	405	PDTS30	0.010	0.035	2
RPD732	5.75	6.33	0.58	10623	5.09	3.68	1073	1081	PDTS30	0.006	0.035	6
R726A	6.08	6.33	0.25	3986	4.43	4.24	1650	1657	PDTS30	0.007	0.035	2
R726*	6.58	7.25	0.67	4179	1.73	4.39	2568	2576	PDTS30	0.006	0.035	2
RPD726	7.67	7.92	0.25	4959	5.51	3.21	2306	2313	PDTS40_1	0.004	0.035	2
RD744 +	0.00	0.00	0.08	3177	10.59	0.15	0	0	TSR606	0.006	0.035	1
RPD720 +	9.25	9.25	0.08	1840	6.13	10.82	4040	4048	Channel	0.010	0.035	1
RD716	7.67	7.25	-0.42	4300	-2.84	2.27	198	207	PDTS40_1	0.009	0.035	2
R700*	9.25	9.92	0.67	5757	2.39	4.77	3988	3997	Channel	0.001	0.035	2
RPD748	4.50	4.75	0.25	6476	7.20	4.76	518	527	PDTS40_2	0.015	0.035	3
RPD756	5.25	5.58	0.33	8775	7.39	6.03	1599	1608	PDTS40_2	0.013	0.035	4
R708*	5.50	5.92	0.42	10484	6.93	5.09	1638	1647	PDTS40_2	0.008	0.035	6
R712A	4.83	5.17	0.34	6448	5.27	4.09	551	560	PDTS40_2	0.009	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Existing Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPD708	5.00	5.17	0.17	2780	4.54	3.77	2911	2918	PDTS40_1	0.006	0.035	1
RPD704	5.25	5.50	0.25	5924	6.58	3.77	3146	3152	PDTS40_1	0.006	0.035	4
RD800 +	0.00	0.00	0.08	5888	19.63	0.15	0	0	PDTS40_1	0.006	0.035	2
R810*	9.75	10.17	0.42	10685	7.07	4.10	4062	4068	PDTS40_1	0.006	0.035	8
RAF803	4.67	4.83	0.16	5287	9.18	4.51	2001	2010	TSAF10	0.002	0.035	3
RAF805	4.50	5.17	0.67	6821	2.83	2.57	618	627	PDTS40_1	0.006	0.035	6
RAF807	4.67	4.75	0.08	2485	8.63	6.54	2904	2913	TSAF10	0.004	0.035	1
RAF810	10.17	10.50	0.33	8372	7.05	4.70	4048	4052	PDTS40_1	0.008	0.035	3
RAF854	4.08	4.17	0.09	2113	6.52	4.77	792	801	TSAF10	0.005	0.035	1
RAF852	4.08	4.17	0.09	1378	4.25	5.23	1167	1176	TSAF10	0.004	0.035	1
RAF864	4.25	4.67	0.42	4666	3.09	1.85	74	64	TSAF20	0.003	0.035	1
RAF862	4.00	4.08	0.08	2136	7.42	4.03	457	466	TSAF20	0.005	0.035	1
RAF866	4.17	4.42	0.25	6743	7.49	4.29	616	625	TSAF20	0.004	0.035	1
RSV258	4.42	4.58	0.16	2155	3.74	3.52	420	428	TSR248	0.018	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation
** Modified Typical X-Section
x Modified Time To Peak Used

D.3.5 NSTEP Check Data: 100-yr 24-hr Future Conditions

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWT140	13.00	13.33	0.33	13053	10.99	6.56	1981	1988	WTTS20_1	0.019	0.035	4
RWT130	13.17	13.75	0.58	5750	2.75	4.28	2705	2714	Channel	0.001	0.035	5
RWT160	12.58	14.25	1.67	18961	3.15	2.41	409	417	WTTS10_1	0.012	0.035	12
R150A	12.92	13.17	0.25	9557	10.62	9.53	2850	2857	WTTS20_2	0.021	0.035	2
RWT150	13.08	13.50	0.42	16082	10.64	6.44	3161	3166	WTTS20_1	0.013	0.035	7
RWT120	13.50	14.08	0.58	6168	2.95	5.41	6330	6339	Channel	0.001	0.035	7
RWT110	14.08	14.75	0.67	7640	3.17	5.36	6116	6125	Channel	0.001	0.035	5
RWT100	14.67	15.08	0.41	4778	3.24	5.30	5872	5881	Channel	0.001	0.035	1
RTW406	12.08	16.67	4.59	14969	0.91	0.51	31	22	TSR408	0.008	0.04	6
RTW408	12.83	15.92	3.09	16567	1.49	1.21	235	243	TSR408	0.007	0.04	10
RTW404	15.08	15.33	0.25	2936	3.26	5.31	5878	5887	Channel	0.001	0.035	2
RIW371	12.08	14.67	2.59	11583	1.24	0.23	11	1	TSR371	0.009	0.04	15
RIW366	12.33	12.83	0.50	9657	5.36	4.34	693	702	IWTS30_2	0.007	0.04	6
RIW377	12.33	13.17	0.84	6588	2.18	0.94	68	59	TSR371	0.010	0.04	6
RD371	12.08	12.33	0.25	1409	1.57	0.53	22	12	WITS130	0.001	0.035	1
RIW374	12.17	14.08	1.91	20437	2.97	1.39	272	280	TSR371	0.008	0.04	15
RIW386	12.67	13.75	1.08	10311	2.65	2.32	201	210	IWTS20_1	0.008	0.035	6
RIW382	12.33	12.83	0.50	4964	2.76	1.51	218	227	TSR371	0.012	0.04	3
RD382A	12.33	12.42	0.09	1172	3.62	1.52	70	60	WITS130	0.007	0.035	1
RIW384	12.33	12.75	0.42	4694	3.10	1.30	123	131	TSR371	0.012	0.04	3
RIW381	12.42	12.75	0.33	4964	4.18	1.69	452	459	TSR371	0.010	0.04	3
R359*	12.83	13.17	0.34	9280	7.58	4.99	729	738	IWTS30_2	0.010	0.04	4
RIW359	12.83	13.17	0.34	13031	10.65	6.58	2516	2524	IWTS30_2	0.006	0.04	4
RIW389	12.33	13.83	1.50	11459	2.12	1.04	72	63	TSR371	0.012	0.04	6
RIW394	13.00	13.25	0.25	7697	8.55	7.69	2479	2486	IWTS10_1	0.013	0.035	2
R390A	13.17	13.42	0.25	8577	9.53	7.97	2824	2833	IWTS10_1	0.013	0.035	4

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW390	13.42	13.75	0.33	11626	9.79	6.23	2814	2820	IWTS20_1	0.010	0.035	5
RIW388	13.75	14.00	0.25	7726	8.58	5.72	3194	3201	IWTS20_2	0.009	0.04	4
RIW357 **	14.08	14.58	0.50	16693	9.27	5.95	2382	2391	IWTS30_1	0.008	0.04	9
RIW353	13.33	13.58	0.25	7496	8.33	3.95	4564	4570	IWTS40_1	0.005	0.04	2
RIW312	12.67	13.50	0.83	8292	2.78	3.21	229	238	TSR375	0.010	0.04	1
RD312	12.67	12.83	0.16	1034	1.80	1.62	74	65	WITS130	0.008	0.035	1
RIW365	12.75	13.25	0.50	7351	4.08	3.68	282	291	IWTS30_1	0.009	0.04	5
RD365	12.75	12.92	0.17	1700	2.78	1.43	40	30	WITS130	0.011	0.035	2
RIW369	12.92	13.17	0.25	6797	7.55	3.22	257	266	TSR375	0.009	0.04	4
RD357	14.00	14.08	0.08	2791	9.69	4.58	828	837	IWTS30_1	0.008	0.04	2
RIW363	13.08	13.58	0.50	11127	6.18	4.79	1032	1041	IWTS30_1	0.008	0.04	4
RD369	12.75	13.08	0.33	1927	1.62	1.96	195	204	WITS130	0.005	0.035	1
RIW368	12.83	13.50	0.67	11648	4.83	3.50	279	288	TSR375	0.010	0.04	6
RIW360	12.25	12.42	0.17	2593	4.24	2.60	636	644	TWTS20	0.008	0.035	1
RIW397	12.83	13.42	0.59	21294	10.03	7.48	3498	3501	TWTS10	0.021	0.035	6
RIW395	13.17	13.42	0.25	13324	14.80	8.89	7775	7777	TWTS10	0.017	0.035	3
RIW387 + **	12.67	12.67	0.08	1005	3.35	3.67	1080	1088	TWTS20	0.014	0.035	1
RIW396	13.33	13.50	0.17	6512	10.64	8.53	8246	8249	TWTS10	0.014	0.035	2
RIW380 **	13.50	14.58	1.08	16914	4.35	5.43	5653	5655	TWTS20	0.013	0.035	11
RIW370 **	14.58	15.08	0.50	7248	4.03	4.79	5501	5505	TWTS20	0.010	0.035	3
RIW349	15.08	15.17	0.09	4331	13.37	4.58	2089	2096	TWTS20	0.016	0.035	2
RD349	15.08	15.42	0.34	4244	3.47	4.46	3262	3265	TWTS20	0.011	0.035	1
RIW356	15.25	15.42	0.17	2643	4.32	3.06	5333	5335	TSR371	0.009	0.04	1
RIW354	15.42	15.75	0.33	4523	3.81	2.85	5226	5226	TSR371	0.007	0.04	2
RIW372	12.17	13.42	1.25	15367	3.41	2.66	129	139	TSR375	0.010	0.04	9
RD372	12.17	12.42	0.25	1828	2.03	1.33	100	91	WITS130	0.003	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW375	12.58	13.42	0.84	13330	4.41	3.51	294	303	TSR375	0.010	0.04	8
RIW364	15.75	16.50	0.75	10402	3.85	2.88	5221	5224	TSR371	0.007	0.04	7
RD363	13.08	13.25	0.17	3820	6.24	4.28	486	495	IWTS30_1	0.009	0.04	1
RIW351	13.08	16.33	3.25	24311	2.08	1.70	68	58	IWTS30_2	0.008	0.04	10
RIW346	16.42	16.67	0.25	3706	4.12	4.33	5289	5294	TWTS30	0.005	0.04	2
RIW338	16.67	17.08	0.41	7227	4.90	4.61	5234	5240	TWTS30	0.006	0.04	5
RIW326	12.25	12.92	0.67	8066	3.34	1.98	239	248	TWTS30	0.006	0.04	5
RIW334	17.08	17.92	0.84	21501	7.11	5.00	5178	5183	TWTS40	0.007	0.04	12
RD351	13.08	13.42	0.34	6586	5.38	3.95	481	490	IWTS30_1	0.008	0.04	3
RIW361	13.50	14.25	0.75	17152	6.35	4.94	1557	1565	IWTS30_1	0.006	0.04	12
R350*	13.67	14.00	0.33	8310	6.99	4.53	6253	6257	IWTS40_1	0.006	0.04	3
RIW330	14.00	14.17	0.17	2771	4.53	3.77	6314	6320	IWTS40_2	0.005	0.04	1
RIW322	14.08	14.75	0.67	12886	5.34	3.91	6681	6685	IWTS40_2	0.005	0.04	12
RIW318	12.50	14.42	1.92	17570	2.54	2.18	299	308	TSR294	0.005	0.04	15
RIW310	12.67	12.75	0.08	860	2.99	1.56	683	691	IWTS50	0.002	0.04	1
RIW314 **	14.92	16.08	1.16	20068	4.81	3.99	6992	6997	IWTS50	0.005	0.04	15
RIW300	16.08	16.50	0.42	6125	4.05	3.38	6894	6896	TWTS50	0.004	0.04	3
RIW302	17.25	17.50	0.25	5720	6.36	3.80	10613	10616	TWTS50	0.004	0.04	3
R264A	12.75	13.25	0.50	4042	2.25	2.17	1460	1467	TSR264A	0.003	0.04	1
RSV264	13.00	13.50	0.50	4870	2.71	2.40	2153	2161	TSR264A	0.003	0.04	1
RSV298	12.83	14.17	1.34	15129	3.14	2.63	460	469	TSR294	0.006	0.04	14
RSV286	12.50	12.75	0.25	3544	3.94	3.26	1082	1091	TSR294	0.006	0.04	1
RSV284	12.67	13.42	0.75	12013	4.45	3.33	1076	1084	TSR294	0.006	0.04	4
RSV290	12.42	13.58	1.16	13500	3.23	2.66	453	462	TSR294	0.006	0.04	5
RSV272	13.33	13.42	0.09	1628	5.02	4.10	1825	1833	SVTS50_1	0.006	0.04	1
RSV294	12.67	13.50	0.83	14316	4.79	3.63	1541	1549	TSR294	0.006	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RSV276	13.42	13.50	0.08	1016	3.53	4.26	3627	3634	SVTS50_1	0.004	0.04	1
RSV280 **	13.58	13.83	0.25	6288	6.99	3.97	4120	4128	SVTS50_1	0.003	0.04	3
RSV268	12.42	12.75	0.33	2946	2.48	2.08	1073	1082	SVTS50_1	0.001	0.04	1
RSV260	14.67	14.92	0.25	6946	7.72	4.77	4514	4520	SVTS50_1	0.005	0.04	5
RSV252	12.25	13.25	1.00	9744	2.71	1.48	70	60	SVTS10	0.009	0.04	5
RSV254	12.17	13.25	1.08	10928	2.81	1.47	64	54	SVTS10	0.010	0.04	6
RSV219	12.25	12.75	0.50	5058	2.81	2.25	834	842	SVTS10	0.004	0.04	3
RSV251	12.25	13.33	1.08	12592	3.24	1.95	134	143	SVTS10	0.010	0.04	8
RSV250	12.25	13.42	1.17	11765	2.79	1.51	64	55	SVTS10	0.011	0.04	8
RSV218	12.58	13.00	0.42	4698	3.11	2.52	1456	1465	SVTS10	0.004	0.04	2
RSV248	12.67	13.17	0.50	7772	4.32	3.06	364	373	TSR248	0.014	0.035	3
RD248	12.67	12.92	0.25	4588	5.10	3.00	358	367	SVTS10	0.016	0.04	2
RSV244	13.00	13.75	0.75	11106	4.11	3.26	1087	1094	SVTS10	0.010	0.04	8
RSV216 **	13.42	13.75	0.33	7196	6.06	2.95	2346	2352	SVTS10	0.004	0.04	5
RSV236	12.25	13.58	1.33	9734	2.03	1.93	275	284	SVTS20_1	0.003	0.04	8
R242* **	12.67	13.33	0.66	13351	5.62	4.12	2572	2580	SVTS10	0.010	0.04	9
RSV220	13.58	14.00	0.42	10623	7.03	5.16	7777	7783	SVTS50_2	0.004	0.04	6
R230*	12.50	12.83	0.33	8744	7.36	4.26	3225	3230	SVTS30	0.009	0.04	6
RSV212 **	13.75	14.33	0.58	9922	4.75	3.24	8668	8668	TSR408	0.005	0.04	6
RSV202	12.50	13.00	0.50	6617	3.68	2.03	971	978	TWTS50	0.004	0.04	5
RSV210	12.08	13.08	1.00	12156	3.38	2.94	706	715	SVTS40	0.007	0.04	11
R205*	12.25	13.08	0.83	9517	3.19	3.01	606	614	SVTS40	0.008	0.04	1
RSV203	12.17	12.75	0.58	7461	3.57	1.59	63	53	SVTS40	0.009	0.04	7
RSV200 **	17.00	17.25	0.25	5688	6.32	4.24	14818	14815	TWTS50	0.005	0.04	5
RTW416	12.50	13.75	1.25	18065	4.01	2.24	398	407	WITS30	0.005	0.04	15
RTW420	12.42	13.33	0.91	12733	3.89	2.37	589	598	WITS30	0.005	0.04	10

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW414	12.08	13.17	1.09	10139	2.58	1.84	809	814	TSR408	0.007	0.04	8
RTW410 **	17.25	17.92	0.67	11703	4.85	4.25	14917	14917	TWTS50	0.005	0.04	8
RTW402	15.42	15.50	0.08	2375	8.25	7.27	19357	19365	Channel	0.001	0.035	1
RTW448	12.67	13.58	0.91	8794	2.68	1.96	152	161	WITS10	0.010	0.035	5
RD448	12.67	12.83	0.16	1591	2.76	1.42	35	25	WITS130	0.013	0.035	1
R446A	12.75	13.33	0.58	6777	3.25	2.40	209	218	WITS130	0.009	0.035	4
RTW446	13.25	13.67	0.42	6941	4.59	2.47	471	480	WITS20	0.009	0.04	4
RTW432	12.75	13.17	0.42	8990	5.95	2.85	748	757	TWTS30	0.006	0.04	7
RTW459	12.83	13.08	0.25	6625	7.36	2.68	339	348	TWTS20	0.013	0.035	2
RD380 **	13.50	13.67	0.17	1142	1.87	2.62	2185	2193	TWTS20	0.004	0.035	1
RTW462	13.58	13.92	0.34	6520	5.33	4.32	2167	2173	TWTS20	0.014	0.035	2
R450A	12.83	13.25	0.42	5936	3.93	3.17	518	526	WITS10	0.015	0.035	1
R450B	13.83	14.50	0.67	18811	7.80	4.46	2593	2597	WITS10	0.012	0.035	8
RD446A +	0.00	0.00	0.08	2942	9.81	0.18	0	0	WITS130	0.009	0.035	1
RTW450	14.50	14.75	0.25	7274	8.08	4.00	2634	2640	WITS10	0.009	0.035	4
RTW444	14.75	14.92	0.17	2739	4.48	3.86	2586	2593	WITS20	0.009	0.04	1
RTW460	12.92	13.17	0.25	4935	5.48	4.03	1108	1114	WITS10	0.017	0.035	2
RTW458	13.08	13.25	0.17	3227	5.27	3.97	1410	1415	WITS10	0.014	0.035	2
RTW456	13.25	13.42	0.17	4821	7.88	3.80	1410	1416	WITS10	0.012	0.035	2
RTW454	13.42	14.33	0.91	13093	4.00	2.73	488	496	WITS10	0.010	0.035	10
R452A	12.75	13.75	1.00	16523	4.59	3.32	667	675	WITS10	0.014	0.035	11
R452B	13.75	14.42	0.67	9296	3.85	3.19	1188	1196	WITS10	0.008	0.035	4
RD450	14.50	14.67	0.17	2017	3.30	1.84	128	137	WITS130	0.006	0.035	1
RTW452	14.58	15.08	0.50	8151	4.53	3.36	1328	1336	WITS20	0.010	0.04	6
R442*	15.00	15.58	0.58	9088	4.35	3.79	3553	3557	WITS20	0.007	0.04	6
RTW434	15.50	16.00	0.50	7363	4.09	3.95	3717	3725	TWTS30	0.005	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW436	12.25	13.17	0.92	13449	4.06	2.45	567	576	TWTS30	0.005	0.04	10
RTW429	12.33	13.17	0.84	3703	1.22	1.24	333	342	TSR429	0.001	0.04	2
RD454	13.42	13.58	0.16	3342	5.80	4.85	940	949	WITS90_2	0.014	0.035	1
R576A	12.83	13.42	0.59	8797	4.14	3.31	513	520	WITS10	0.017	0.035	6
R576B	13.42	15.25	1.83	18394	2.79	2.54	321	329	WITS10	0.011	0.035	16
RTW485	12.92	13.00	0.08	1831	6.36	2.79	1719	1727	TSR482	0.007	0.04	1
RTW484	12.75	13.42	0.67	10402	4.31	3.13	1864	1871	TSR482	0.009	0.04	7
R580B	12.33	12.83	0.50	8181	4.55	2.83	218	227	WITS10	0.020	0.035	5
R580A	12.58	13.75	1.17	21213	5.04	3.55	1617	1625	WITS10	0.009	0.035	14
RD580B	12.33	12.83	0.50	9430	5.24	3.54	184	193	WITS90_1	0.020	0.035	6
RWI578	12.92	13.50	0.58	12424	5.95	3.60	370	379	WITS90_1	0.013	0.035	8
RWI580	13.67	14.08	0.41	8541	5.79	4.02	1938	1945	WITS10	0.011	0.035	5
RD576B	13.42	14.25	0.83	13552	4.54	2.36	230	239	WITS10	0.012	0.035	9
RWI576	14.08	14.50	0.42	8726	5.77	3.18	949	957	WITS10	0.010	0.035	5
RTW482	14.50	15.00	0.50	7471	4.15	2.57	990	998	TSR482	0.008	0.04	6
RTW480	13.42	13.83	0.41	4817	3.26	3.44	2786	2792	TSR482	0.008	0.04	2
RTW478	13.83	14.42	0.59	5969	2.81	2.09	2697	2705	TSR478	0.001	0.04	3
RTW430	16.08	16.58	0.50	10141	5.63	4.29	4759	4764	WITS30	0.006	0.04	1
RTW418	16.58	17.00	0.42	7044	4.66	4.23	4512	4518	WITS30	0.006	0.04	1
RTW424	12.25	12.50	0.25	5625	6.25	3.27	1844	1852	WITS30	0.005	0.04	3
RTW422	17.00	18.58	1.58	22821	4.01	3.57	4375	4380	WITS30	0.004	0.04	17
RTW400	15.58	15.83	0.25	6826	7.58	12.11	21447	21452	Channel	0.004	0.035	3
RWI504	15.83	15.92	0.09	1494	4.61	7.47	21418	21426	Channel	0.001	0.035	1
RD576	14.08	14.33	0.25	4830	5.37	3.37	1235	1242	WITS10	0.010	0.035	3
RWI574	12.25	13.33	1.08	14010	3.60	1.92	123	132	WITS10	0.011	0.035	7
RWI572	12.33	13.17	0.84	23543	7.79	4.84	1392	1399	WITS90_1	0.012	0.035	9

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI570	12.50	13.00	0.50	12212	6.78	4.74	1046	1054	WITS90_1	0.014	0.035	4
RWI566	12.50	13.08	0.58	10390	4.98	3.47	358	367	WITS90_1	0.012	0.035	8
RWI564	13.17	13.67	0.50	9364	5.20	4.11	737	746	WITS90_1	0.012	0.035	4
R562*	13.25	13.92	0.67	14581	6.05	4.12	2071	2076	WITS40	0.011	0.035	8
R560A	12.75	13.75	1.00	16408	4.56	3.15	722	730	WITS10	0.012	0.035	9
RWI560	13.58	14.33	0.75	11699	4.33	4.31	4955	4960	WITS40	0.007	0.035	8
RD482 +	0.00	0.00	0.08	2439	8.13	0.19	0	0	WITS130	0.009	0.035	1
RWI582	12.25	12.83	0.58	5153	2.47	1.82	269	278	WITS10	0.005	0.035	2
RWI556	12.00	13.42	1.42	11635	2.28	1.22	46	36	WITS40	0.007	0.035	4
RWI554	14.25	14.33	0.08	4538	15.76	9.27	5146	5154	WITS50	0.014	0.035	2
RWI552 +	14.33	14.33	0.08	1732	5.77	5.16	5170	5173	WITS70	0.012	0.04	1
RWI584	12.42	12.67	0.25	1409	1.57	1.26	812	821	WITS70	0.001	0.04	1
RWI550	14.67	15.00	0.33	6201	5.22	4.48	5100	5105	WITS70	0.008	0.04	2
RWI548	12.25	13.17	0.92	13444	4.06	3.18	228	218	WITS90_2	0.012	0.035	7
RWI546	13.00	13.17	0.17	5296	8.65	3.17	511	519	WITS90_3	0.009	0.035	3
RWI544	12.50	13.33	0.83	9910	3.32	2.59	509	517	WITS40	0.008	0.035	5
RWI540	12.83	13.00	0.17	4350	7.11	4.73	771	779	WITS90_1	0.017	0.035	1
R538A	12.92	13.67	0.75	18226	6.75	5.05	1128	1136	WITS90_2	0.013	0.035	8
RWI538	13.58	14.25	0.67	15096	6.26	4.21	1599	1607	WITS90_3	0.008	0.035	9
RWI534	12.33	12.58	0.25	3889	4.32	3.13	398	406	WITS90_3	0.011	0.035	2
R530*	12.58	13.25	0.67	14751	6.12	4.03	1241	1249	WITS90_3	0.008	0.035	9
RD544	12.50	13.08	0.58	9401	4.50	3.14	1117	1125	WITS40	0.008	0.035	6
RPI663	12.92	13.75	0.83	14316	4.79	4.37	298	308	PITS10_1	0.015	0.035	10
RPI660	13.50	13.67	0.17	5729	9.36	5.40	883	891	PITS10_1	0.013	0.035	1
RPI654 **	12.92	13.25	0.33	6847	5.76	5.82	2245	2252	PITS10_2	0.010	0.035	4
RPI651 **	13.08	13.33	0.25	5658	6.29	5.45	3252	3258	PITS10_2	0.007	0.035	3

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
R645A	12.75	13.17	0.42	8664	5.73	4.87	876	885	PITS10_2	0.012	0.035	5
RD654	12.92	13.58	0.66	11215	4.72	4.03	553	562	PITS10_2	0.010	0.035	6
RPI689	12.92	13.33	0.41	18798	12.74	10.69	6797	6802	WITS100	0.017	0.035	4
RPI687	13.25	13.42	0.17	10777	17.61	11.98	10371	10374	WITS100	0.017	0.035	2
RPI684	13.58	13.92	0.34	14047	11.48	10.01	9741	9747	WITS110_1	0.014	0.035	3
RPI681	13.83	14.50	0.67	19831	8.22	7.69	9383	9387	WITS110_2	0.011	0.035	7
RPI690 **	14.50	14.67	0.17	2826	4.62	4.27	6800	6807	WITS110_2	0.003	0.035	1
RD678	14.50	14.92	0.42	6108	4.04	3.62	2306	2314	WITS110_2	0.004	0.035	1
RWI542	15.75	15.92	0.17	2706	4.42	2.75	407	416	WITS90_3	0.007	0.035	1
RWI529	15.42	15.58	0.16	3670	6.37	2.37	437	445	WITS70	0.010	0.04	1
RWI516	15.00	15.67	0.67	11711	4.86	3.75	5226	5229	WITS70	0.005	0.04	6
RDCP07	15.75	16.25	0.50	6956	3.86	2.90	420	429	WITS120	0.008	0.035	2
RD529	15.42	15.83	0.41	4871	3.30	0.17	7	0	WITS130	0.008	0.035	2
RWI528	15.67	16.00	0.33	8240	6.94	2.17	461	470	WITS70	0.007	0.04	1
RDCPOT +	0.00	0.00	0.08	8638	28.79	0.15	0	0	WITS70	0.007	0.04	2
RWI527	12.33	12.75	0.42	5909	3.91	2.28	585	593	WITS70	0.007	0.04	3
R508* **	15.75	16.33	0.58	12366	5.92	4.68	5580	5584	WITS130	0.005	0.035	7
R510A	12.33	13.50	1.17	17257	4.10	2.14	672	680	WITS70	0.005	0.04	8
RWI510	16.25	16.67	0.42	6492	4.29	3.56	4630	4634	WITS70	0.005	0.04	2
RWI502	16.08	16.17	0.09	1679	5.18	11.02	24569	24577	Channel	0.003	0.035	1
RDCP08	15.75	16.00	0.25	4229	4.70	3.27	420	429	WITS120	0.011	0.035	1
RWI526	15.58	16.50	0.92	11922	3.60	2.72	431	440	WITS120	0.007	0.035	6
RDCP09	15.75	16.67	0.92	14618	4.41	2.99	421	429	WITS120	0.009	0.035	8
RD527	12.33	13.00	0.67	7666	3.18	0.47	12	2	WITS130	0.007	0.035	2
RWI525	12.42	13.08	0.66	11015	4.64	3.57	1453	1461	WITS130	0.006	0.035	6
RD525	12.42	13.42	1.00	6496	1.80	1.59	83	73	WITS130	0.007	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI524	12.42	12.83	0.41	4526	3.07	2.86	640	649	WITS130	0.006	0.035	2
RWI506	12.92	13.08	0.16	5235	9.09	2.90	2573	2580	WITS70	0.004	0.04	3
RD508	16.42	16.67	0.25	5200	5.78	2.65	1053	1060	WITS70	0.007	0.04	2
RWI500	26.58	27.17	0.59	5659	2.66	4.68	3734	3743	Channel	0.001	0.035	3
RPI635	27.17	27.92	0.75	7557	2.80	4.68	3732	3741	Channel	0.001	0.035	6
RDCP11	15.75	16.08	0.33	6377	5.37	3.73	433	442	PITS10_2	0.009	0.035	5
RDCP12	15.75	16.08	0.33	6159	5.18	3.16	421	430	PITS30	0.009	0.035	2
RPI618	15.67	16.25	0.58	10443	5.00	3.12	411	420	PITS20	0.008	0.035	5
RDCP13	15.75	16.42	0.67	11034	4.57	3.12	431	440	PITS30	0.009	0.035	6
RD618	15.67	15.92	0.25	4541	5.05	3.41	464	473	PITS20	0.009	0.035	2
RPI615	12.33	12.75	0.42	5109	3.38	3.91	930	939	PITS20	0.008	0.035	2
RPI612	12.67	13.00	0.33	5754	4.84	2.82	383	392	PITS20	0.006	0.035	3
RDCP14	15.75	16.92	1.17	20386	4.84	2.97	371	380	PITS30	0.009	0.035	12
RPI609	12.67	12.83	0.16	4513	7.84	6.31	1373	1382	PITS40	0.006	0.035	2
RD612	12.67	13.42	0.75	11125	4.12	3.80	1115	1124	PITS20	0.007	0.035	8
RPI621	13.25	13.42	0.17	2775	4.53	3.89	1367	1375	TSR621	0.008	0.035	1
RDCP10	15.75	16.17	0.42	6701	4.43	2.89	431	440	WITS120	0.008	0.035	4
RPI628	12.17	13.00	0.83	14427	4.83	3.22	552	561	PITS20	0.007	0.035	6
R624A	12.58	13.50	0.92	11809	3.57	2.99	1874	1882	PDTS40_1	0.004	0.035	6
RD524	12.42	12.67	0.25	2235	2.48	0.10	6	0	WITS130	0.003	0.035	1
RPI639	12.58	13.33	0.75	5380	1.99	1.74	138	148	WITS130	0.005	0.035	2
RPI636	12.33	12.42	0.09	728	2.25	3.39	407	415	WITS130	0.014	0.035	1
RPI624 **	13.50	13.75	0.25	5060	5.62	3.57	2372	2378	TSR621	0.004	0.035	3
RPI633	25.00	25.50	0.50	5834	3.24	5.02	4791	4800	Channel	0.001	0.035	4
RDCP15	17.00	17.42	0.42	9602	6.35	3.14	341	350	PITS30	0.011	0.035	5
R606A	17.58	18.08	0.50	12583	6.99	2.68	221	230	PDTS30	0.008	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPI606	12.42	12.83	0.41	2654	1.80	2.43	686	694	TSR606	0.006	0.035	1
RD606A	17.58	17.92	0.34	7507	6.13	2.40	154	163	PITS30	0.009	0.035	4
RPI604	12.50	12.83	0.33	7442	6.26	2.89	364	373	PDTS30	0.007	0.035	4
RD600A	12.67	13.33	0.66	4775	2.01	1.94	1319	1327	TSBEAR	0.001	0.035	2
RPI603	13.17	13.42	0.25	3427	3.81	3.27	2499	2507	PDTS40_1	0.004	0.035	1
RPI600	24.75	25.17	0.42	4937	3.27	5.18	5380	5389	Channel	0.001	0.035	2
RDCP16	17.00	17.42	0.42	10754	7.11	4.64	1184	1192	PDTS30	0.011	0.035	8
RDCP17	17.00	17.25	0.25	10400	11.56	3.53	391	400	PDTS30	0.012	0.035	4
RPD740	17.50	17.83	0.33	5434	4.57	4.08	1651	1659	PDTS30	0.006	0.035	5
R726B	17.83	18.00	0.17	4094	6.69	4.52	1653	1661	PDTS30	0.008	0.035	2
RDCP18	17.00	17.42	0.42	14927	9.87	3.36	394	403	PDTS30	0.010	0.035	5
RPD736	14.17	14.25	0.08	1894	6.58	2.79	475	484	PDTS30	0.005	0.035	1
RDCP19	17.00	17.17	0.17	5902	9.64	5.17	1193	1200	PDTS30	0.015	0.035	2
RPD760	12.67	12.83	0.16	5149	8.94	3.32	372	381	PDTS30	0.010	0.035	2
RPD732	13.67	14.33	0.66	10623	4.47	3.88	1327	1334	PDTS30	0.006	0.035	6
R726A	14.17	14.33	0.16	3986	6.92	4.43	1963	1971	PDTS30	0.007	0.035	2
R726*	14.50	15.08	0.58	4179	2.00	4.69	3317	3324	PDTS30	0.006	0.035	2
RPD726	15.00	15.25	0.25	4959	5.51	3.26	2478	2485	PDTS40_1	0.004	0.035	2
RD744 +	0.00	0.00	0.08	3177	10.59	0.15	0	0	TSR606	0.006	0.035	1
RPD720 +	14.67	14.67	0.08	1840	6.13	12.98	7503	7511	Channel	0.010	0.035	1
RD716	15.00	15.42	0.42	4300	2.84	3.30	876	885	PDTS40_1	0.009	0.035	2
R700*	14.75	15.42	0.67	5757	2.39	5.75	7945	7953	Channel	0.001	0.035	2
RPD748	12.33	12.67	0.34	6476	5.29	4.59	450	459	PDTS40_2	0.015	0.035	3
RPD756	12.83	13.17	0.34	8775	7.17	5.93	1502	1509	PDTS40_2	0.013	0.035	3
R708*	13.00	13.42	0.42	10484	6.93	5.12	1669	1678	PDTS40_2	0.008	0.035	4
R712A	12.58	13.00	0.42	6448	4.26	3.70	374	383	PDTS40_2	0.009	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 24-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPD708	13.08	13.17	0.09	2780	8.58	3.85	3156	3161	PDTS40_1	0.006	0.035	1
RPD704	13.17	13.50	0.33	5924	4.99	3.83	3356	3363	PDTS40_1	0.006	0.035	3
RD800 +	0.00	0.00	0.08	5888	19.63	0.15	0	0	PDTS40_1	0.006	0.035	2
R810*	15.17	15.50	0.33	10685	8.99	5.01	9023	9023	PDTS40_1	0.006	0.035	4
RAF803	12.50	12.75	0.25	5287	5.87	4.32	1715	1724	TSAF10	0.002	0.035	3
RAF805	12.33	12.75	0.42	6821	4.51	2.43	497	506	PDTS40_1	0.006	0.035	4
RAF807	12.67	12.75	0.08	2485	8.63	6.32	2567	2575	TSAF10	0.004	0.035	1
RAF810	15.42	15.67	0.25	8372	9.30	5.79	9258	9262	PDTS40_1	0.008	0.035	3
RAF854	12.08	12.17	0.09	2113	6.52	4.22	530	539	TSAF10	0.005	0.035	1
RAF852 +	12.17	12.17	0.08	1378	4.59	4.66	788	798	TSAF10	0.004	0.035	1
RAF864	12.25	12.83	0.58	4666	2.23	1.51	45	35	TSAF20	0.003	0.035	1
RAF862	12.00	12.08	0.08	2136	7.42	3.51	283	293	TSAF20	0.005	0.035	1
RAF866	12.17	12.50	0.33	6743	5.68	3.84	420	430	TSAF20	0.004	0.035	1
RSV258	12.42	12.58	0.16	2155	3.74	3.35	358	366	TSR248	0.018	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation
** Modified Typical X-Section
x Modified Time To Peak Used

D.3.6 NSTEP Check Data: 100-yr 6-hr Future Conditions

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWT140	5.17	5.42	0.25	13053	14.50	6.70	2148	2155	WTTS20_1	0.019	0.035	4
RWT130	5.25	5.75	0.50	5750	3.19	4.36	2889	2898	Channel	0.001	0.035	5
RWT160	4.58	6.25	1.67	18961	3.15	2.61	550	558	WTTS10_1	0.012	0.035	12
R150A	5.08	5.25	0.17	9557	15.62	9.59	2922	2929	WTTS20_2	0.021	0.035	2
RWT150	5.17	5.58	0.41	16082	10.90	6.43	3152	3158	WTTS20_1	0.013	0.035	5
RWT120	5.58	6.17	0.59	6168	2.90	5.34	6038	6047	Channel	0.001	0.035	7
RWT110	6.08	6.83	0.75	7640	2.83	5.28	5779	5788	Channel	0.001	0.035	5
RWT100	6.75	7.08	0.33	4778	4.02	5.20	5471	5480	Channel	0.001	0.035	1
RTW406	4.08	8.33	4.25	14969	0.98	0.58	41	32	TSR408	0.008	0.04	6
RTW408	4.83	7.58	2.75	16567	1.67	1.35	327	334	TSR408	0.007	0.04	10
RTW404	7.17	7.42	0.25	2936	3.26	5.18	5371	5380	Channel	0.001	0.035	2
RIW371	4.08	6.58	2.50	11583	1.29	0.34	13	3	TSR371	0.009	0.04	15
RIW366	4.33	4.83	0.50	9657	5.36	4.72	869	878	IWTS30_2	0.007	0.04	4
RIW377	4.42	5.17	0.75	6588	2.44	1.07	100	91	TSR371	0.010	0.04	6
RD371	4.08	4.33	0.25	1409	1.57	0.68	36	26	WITS130	0.001	0.035	1
RIW374	4.17	5.83	1.66	20437	3.42	1.53	395	402	TSR371	0.008	0.04	15
RIW386	4.58	5.42	0.84	10311	3.41	2.66	294	303	IWTS20_1	0.008	0.035	6
RIW382	4.33	4.83	0.50	4964	2.76	1.57	258	267	TSR371	0.012	0.04	3
RD382A	4.33	4.42	0.09	1172	3.62	2.23	217	227	WITS130	0.007	0.035	1
RIW384	4.33	4.67	0.34	4694	3.84	1.69	323	331	TSR371	0.012	0.04	3
RIW381	4.33	4.67	0.34	4964	4.06	1.79	563	570	TSR371	0.010	0.04	3
R359*	4.75	5.08	0.33	9280	7.81	5.51	951	959	IWTS30_2	0.010	0.04	4
RIW359 **	4.83	5.17	0.34	13031	10.65	6.89	2865	2874	IWTS30_2	0.006	0.04	4
RIW389	4.33	5.67	1.34	11459	2.38	1.16	99	90	TSR371	0.012	0.04	6
RIW394	5.08	5.25	0.17	7697	12.58	7.87	2722	2730	IWTS10_1	0.013	0.035	2
R390A	5.25	5.42	0.17	8577	14.01	8.09	3013	3020	IWTS10_1	0.013	0.035	2

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW390	5.50	5.75	0.25	11626	12.92	6.33	2958	2966	IWTS20_1	0.010	0.035	3
RIW388	5.75	6.00	0.25	7726	8.58	5.78	3305	3313	IWTS20_2	0.009	0.04	2
RIW357 **	5.92	6.50	0.58	16693	7.99	6.00	2465	2474	IWTS30_1	0.008	0.04	6
RIW353	5.33	5.58	0.25	7496	8.33	4.03	4906	4911	IWTS40_1	0.005	0.04	2
RIW312	4.58	5.58	1.00	8292	2.30	3.25	239	249	TSR375	0.010	0.04	1
RD312	4.58	4.67	0.09	1034	3.19	2.30	206	215	WITS130	0.008	0.035	1
RIW365	4.67	5.17	0.50	7351	4.08	3.72	297	307	IWTS30_1	0.009	0.04	5
RD365	4.67	4.83	0.16	1700	2.95	2.70	245	254	WITS130	0.011	0.035	2
RIW369	4.75	5.17	0.42	6797	4.50	3.88	458	467	TSR375	0.009	0.04	4
RD357	5.92	6.08	0.16	2791	4.85	4.60	849	858	IWTS30_1	0.008	0.04	1
RIW363	5.08	5.67	0.59	11127	5.24	4.98	1211	1220	IWTS30_1	0.008	0.04	4
RD369	4.67	4.92	0.25	1927	2.14	2.26	331	340	WITS130	0.005	0.035	1
RIW368	4.75	5.33	0.58	11648	5.58	4.10	456	465	TSR375	0.010	0.04	6
RIW360	4.33	4.42	0.09	2593	8.00	2.71	755	763	TWTS20	0.008	0.035	1
RIW397	4.92	5.42	0.50	21294	11.83	7.75	3910	3916	TWTS10	0.021	0.035	6
RIW395	5.17	5.42	0.25	13324	14.80	9.06	8270	8271	TWTS10	0.017	0.035	3
RIW387 +	4.67	4.67	0.08	1005	3.35	3.86	1312	1319	TWTS20	0.014	0.035	1
RIW396	5.42	5.50	0.08	6512	22.61	8.64	8607	8611	TWTS10	0.014	0.035	1
RIW380 **	5.58	6.58	1.00	16914	4.70	5.46	5792	5796	TWTS20	0.013	0.035	11
RIW370 **	6.58	7.08	0.50	7248	4.03	4.84	5721	5721	TWTS20	0.010	0.035	3
RIW349	7.08	7.17	0.09	4331	13.37	4.62	2168	2172	TWTS20	0.016	0.035	1
RD349 **	7.08	7.33	0.25	4244	4.72	4.52	3450	3454	TWTS20	0.011	0.035	1
RIW356 **	7.25	7.42	0.17	2643	4.32	3.10	5595	5596	TSR371	0.009	0.04	1
RIW354 **	7.42	7.67	0.25	4523	5.03	2.89	5506	5509	TSR371	0.007	0.04	2
RIW372	4.17	5.33	1.16	15367	3.68	2.82	154	164	TSR375	0.010	0.04	9
RD372	4.17	4.42	0.25	1828	2.03	1.68	201	210	WITS130	0.003	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RIW375	4.58	5.33	0.75	13330	4.94	4.01	442	451	TSR375	0.010	0.04	8
RIW364 **	7.67	8.25	0.58	10402	4.98	2.91	5475	5474	TSR371	0.007	0.04	7
RD363	5.08	5.25	0.17	3820	6.24	4.45	565	574	IWTS30_1	0.009	0.04	1
RIW351	4.92	8.08	3.16	24311	2.14	1.82	79	69	IWTS30_2	0.008	0.04	10
RIW346	8.25	8.50	0.25	3706	4.12	4.36	5427	5432	TWTS30	0.005	0.04	2
RIW338	8.50	8.92	0.42	7227	4.78	4.64	5353	5359	TWTS30	0.006	0.04	5
RIW326	4.25	4.83	0.58	8066	3.86	2.24	361	370	TWTS30	0.006	0.04	5
RIW334	9.00	9.83	0.83	21501	7.20	5.01	5220	5227	TWTS40	0.007	0.04	12
RD351	4.92	5.25	0.33	6586	5.54	4.17	605	614	IWTS30_1	0.008	0.04	3
RIW361 **	5.42	6.17	0.75	17152	6.35	5.15	1833	1841	IWTS30_1	0.006	0.04	12
R350*	5.75	6.00	0.25	8310	9.23	4.60	6570	6573	IWTS40_1	0.006	0.04	3
RIW330	6.00	6.17	0.17	2771	4.53	3.81	6589	6594	IWTS40_2	0.005	0.04	1
RIW322	6.17	6.83	0.66	12886	5.42	3.94	6874	6875	IWTS40_2	0.005	0.04	12
RIW318	4.50	6.17	1.67	17570	2.92	2.38	421	430	TSR294	0.005	0.04	15
RIW310	4.67	4.75	0.08	860	2.99	1.67	887	896	IWTS50	0.002	0.04	1
RIW314 **	7.00	8.17	1.17	20068	4.76	3.97	6831	6835	IWTS50	0.005	0.04	15
RIW300	8.17	8.42	0.25	6125	6.81	3.35	6703	6703	TWTS50	0.004	0.04	3
RIW302	9.17	9.50	0.33	5720	4.81	3.73	9849	9849	TWTS50	0.004	0.04	3
R264A	4.83	5.25	0.42	4042	2.67	2.33	1855	1861	TSR264A	0.003	0.04	1
RSV264	5.00	5.42	0.42	4870	3.22	2.55	2648	2655	TSR264A	0.003	0.04	1
RSV298	4.75	5.92	1.17	15129	3.59	2.82	613	622	TSR294	0.006	0.04	14
RSV286	4.50	4.75	0.25	3544	3.94	3.49	1412	1421	TSR294	0.006	0.04	1
RSV284	4.67	5.33	0.66	12013	5.06	3.58	1422	1431	TSR294	0.006	0.04	4
RSV290	4.42	5.42	1.00	13500	3.75	2.90	637	646	TSR294	0.006	0.04	5
RSV272	5.25	5.33	0.08	1628	5.65	4.36	2326	2334	SVTS50_1	0.006	0.04	1
RSV294	4.67	5.42	0.75	14316	5.30	3.85	1952	1959	TSR294	0.006	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RSV276 + **	5.42	5.42	0.08	1016	3.39	4.45	4299	4305	SVTS50_1	0.004	0.04	1
RSV280 **	5.50	5.75	0.25	6288	6.99	4.13	4807	4813	SVTS50_1	0.003	0.04	3
RSV268	4.42	4.75	0.33	2946	2.48	2.22	1386	1394	SVTS50_1	0.001	0.04	1
RSV260 **	6.67	6.92	0.25	6946	7.72	4.88	4937	4944	SVTS50_1	0.005	0.04	5
RSV252	4.25	5.17	0.92	9744	2.94	1.78	106	115	SVTS10	0.009	0.04	5
RSV254	4.17	5.08	0.91	10928	3.34	1.68	96	87	SVTS10	0.010	0.04	6
RSV219	4.33	4.83	0.50	5058	2.81	2.34	975	983	SVTS10	0.004	0.04	3
RSV251	4.25	5.25	1.00	12592	3.50	2.18	205	214	SVTS10	0.010	0.04	8
RSV250	4.17	5.25	1.08	11765	3.03	1.74	98	89	SVTS10	0.011	0.04	8
RSV218 **	4.75	5.08	0.33	4698	3.95	2.63	1726	1733	SVTS10	0.004	0.04	2
RSV248	4.67	5.17	0.50	7772	4.32	3.34	489	497	TSR248	0.014	0.035	3
RD248	4.67	5.00	0.33	4588	3.86	3.20	460	469	SVTS10	0.016	0.04	2
RSV244	5.00	5.75	0.75	11106	4.11	3.46	1374	1381	SVTS10	0.010	0.04	8
RSV216 **	5.33	5.75	0.42	7196	4.76	3.06	2722	2728	SVTS10	0.004	0.04	5
RSV236	4.25	5.50	1.25	9734	2.16	2.13	414	423	SVTS20_1	0.003	0.04	8
R242* **	4.75	5.33	0.58	13351	6.39	4.20	2794	2801	SVTS10	0.010	0.04	9
RSV220 **	5.83	6.25	0.42	10623	7.03	5.15	7745	7752	SVTS50_2	0.004	0.04	6
R230*	4.50	4.92	0.42	8744	5.78	4.27	3271	3276	SVTS30	0.009	0.04	6
RSV212 **	5.83	6.42	0.59	9922	4.67	3.22	8505	8503	TSR408	0.005	0.04	6
RSV202	4.58	4.92	0.34	6617	5.41	2.18	1253	1259	TWTS50	0.004	0.04	5
RSV210	4.08	5.00	0.92	12156	3.67	3.20	1000	1008	SVTS40	0.007	0.04	11
R205*	4.50	5.00	0.50	9517	5.29	3.22	798	807	SVTS40	0.008	0.04	1
RSV203	4.08	4.67	0.59	7461	3.51	1.82	97	88	SVTS40	0.009	0.04	7
RSV200 **	9.17	9.42	0.25	5688	6.32	4.08	12703	12699	TWTS50	0.005	0.04	5
RTW416	4.42	5.58	1.16	18065	4.33	2.46	583	592	WITS30	0.005	0.04	15
RTW420	4.42	5.17	0.75	12733	4.72	2.58	830	839	WITS30	0.005	0.04	10

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW414	4.08	5.08	1.00	10139	2.82	2.04	1109	1114	TSR408	0.007	0.04	8
RTW410 **	9.42	10.00	0.58	11703	5.60	4.06	12502	12498	TWTS50	0.005	0.04	8
RTW402	7.58	7.75	0.17	2375	3.88	6.69	14080	14089	Channel	0.001	0.035	1
RTW448	4.58	5.58	1.00	8794	2.44	1.96	155	164	WITS10	0.010	0.035	5
RD448	4.58	4.75	0.17	1591	2.60	2.33	113	122	WITS130	0.013	0.035	1
R446A	4.58	5.17	0.59	6777	3.19	2.77	359	368	WITS130	0.009	0.035	4
RTW446	5.00	5.50	0.50	6941	3.86	2.65	634	643	WITS20	0.009	0.04	4
RTW432	4.75	5.42	0.67	8990	3.73	3.05	957	965	TWTS30	0.006	0.04	7
RTW459	4.83	5.08	0.25	6625	7.36	2.91	466	474	TWTS20	0.013	0.035	3
RD380 **	5.58	5.67	0.09	1142	3.52	2.69	2432	2439	TWTS20	0.004	0.035	1
RTW462	5.67	6.00	0.33	6520	5.49	4.69	2991	2993	TWTS20	0.014	0.035	2
R450A	4.83	5.08	0.25	5936	6.60	3.53	786	793	WITS10	0.015	0.035	2
R450B	5.92	6.58	0.66	18811	7.92	4.71	3210	3214	WITS10	0.012	0.035	7
RD446A	4.58	4.75	0.17	2942	4.81	0.18	3	0	WITS130	0.009	0.035	1
RTW450	6.50	6.83	0.33	7274	6.12	4.15	3043	3050	WITS10	0.009	0.035	3
RTW444	6.83	7.00	0.17	2739	4.48	4.01	3013	3020	WITS20	0.009	0.04	1
RTW460	4.83	5.25	0.42	4935	3.26	4.09	1176	1182	WITS10	0.017	0.035	2
RTW458	5.08	5.25	0.17	3227	5.27	4.13	1641	1646	WITS10	0.014	0.035	2
RTW456	5.25	5.42	0.17	4821	7.88	3.96	1660	1667	WITS10	0.012	0.035	2
RTW454	5.42	6.17	0.75	13093	4.85	2.87	589	597	WITS10	0.010	0.035	10
R452A	4.75	5.58	0.83	16523	5.53	3.60	918	925	WITS10	0.014	0.035	11
R452B	5.92	6.33	0.41	9296	6.30	3.39	1513	1520	WITS10	0.008	0.035	4
RD450	6.50	6.75	0.25	2017	2.24	2.18	243	252	WITS130	0.006	0.035	1
RTW452	6.50	6.92	0.42	8151	5.39	3.59	1744	1750	WITS20	0.010	0.04	6
R442*	7.00	7.50	0.50	9088	5.05	3.91	4034	4041	WITS20	0.007	0.04	6
RTW434	7.50	8.00	0.50	7363	4.09	4.04	4058	4064	TWTS30	0.005	0.04	5

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RTW436	4.25	5.17	0.92	13449	4.06	2.69	779	788	TWTS30	0.005	0.04	10
RTW429	4.33	5.00	0.67	3703	1.54	1.36	476	485	TSR429	0.001	0.04	2
RD454	5.42	5.50	0.08	3342	11.60	5.05	1104	1112	WITS90_2	0.014	0.035	1
R576A	4.83	5.33	0.50	8797	4.89	3.61	716	723	WITS10	0.017	0.035	6
R576B	5.25	7.08	1.83	18394	2.79	2.67	388	397	WITS10	0.011	0.035	16
RTW485	4.92	5.17	0.25	1831	2.03	2.92	2038	2044	TSR482	0.007	0.04	1
RTW484	5.00	5.67	0.67	10402	4.31	3.25	2164	2170	TSR482	0.009	0.04	7
R580B	4.33	4.75	0.42	8181	5.41	3.12	314	322	WITS10	0.020	0.035	5
R580A	4.67	5.67	1.00	21213	5.89	3.69	1883	1888	WITS10	0.009	0.035	14
RD580B	4.33	4.75	0.42	9430	6.24	3.81	266	257	WITS90_1	0.020	0.035	6
RWI578	4.83	5.42	0.59	12424	5.85	3.92	525	534	WITS90_1	0.013	0.035	8
RWI580	5.67	6.00	0.33	8541	7.19	4.13	2155	2160	WITS10	0.011	0.035	5
RD576B	5.25	6.42	1.17	13552	3.22	2.49	283	292	WITS10	0.012	0.035	9
RWI576	6.00	6.50	0.50	8726	4.85	3.53	1419	1425	WITS10	0.010	0.035	5
RTW482	6.42	6.83	0.41	7471	5.06	2.87	1504	1511	TSR482	0.008	0.04	6
RTW480	5.58	5.92	0.34	4817	3.94	3.56	3162	3168	TSR482	0.008	0.04	2
RTW478	5.92	6.50	0.58	5969	2.86	2.16	3065	3072	TSR478	0.001	0.04	3
RTW430	7.92	8.42	0.50	10141	5.63	4.29	4755	4761	WITS30	0.006	0.04	1
RTW418	8.50	8.75	0.25	7044	7.83	4.22	4478	4482	WITS30	0.006	0.04	1
RTW424	4.25	4.50	0.25	5625	6.25	3.40	2163	2171	WITS30	0.005	0.04	3
RTW422	8.75	10.25	1.50	22821	4.23	3.49	3998	4004	WITS30	0.004	0.04	17
RTW400	7.75	8.00	0.25	6826	7.58	10.89	14378	14386	Channel	0.004	0.035	2
RWI504	8.00	8.08	0.08	1494	5.19	6.72	14313	14321	Channel	0.001	0.035	1
RD576	6.00	6.33	0.33	4830	4.07	3.13	934	942	WITS10	0.010	0.035	3
RWI574	4.17	5.25	1.08	14010	3.60	2.15	188	197	WITS10	0.011	0.035	7
RWI572	4.42	5.17	0.75	23543	8.72	5.04	1639	1646	WITS90_1	0.012	0.035	8

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI570	4.58	5.00	0.42	12212	8.08	5.00	1302	1311	WITS90_1	0.014	0.035	4
RWI566	4.50	5.00	0.50	10390	5.77	3.77	498	507	WITS90_1	0.012	0.035	8
RWI564	5.25	5.58	0.33	9364	7.88	4.37	941	950	WITS90_1	0.012	0.035	4
R562*	5.25	5.92	0.67	14581	6.05	4.29	2423	2430	WITS40	0.011	0.035	8
R560A	4.83	5.67	0.84	16408	5.43	3.34	909	917	WITS10	0.012	0.035	9
RWI560	5.58	6.25	0.67	11699	4.85	4.34	5096	5100	WITS40	0.007	0.035	8
RD482 +	0.00	0.00	0.08	2439	8.13	0.19	0	0	WITS130	0.009	0.035	1
RWI582	4.25	4.67	0.42	5153	3.41	2.05	428	437	WITS10	0.005	0.035	2
RWI556	4.00	5.25	1.25	11635	2.59	1.35	63	53	WITS40	0.007	0.035	4
RWI554	6.17	6.25	0.08	4538	15.76	9.32	5247	5254	WITS50	0.014	0.035	2
RWI552	6.25	6.33	0.08	1732	6.01	5.18	5248	5249	WITS70	0.012	0.04	1
RWI584	4.50	4.67	0.17	1409	2.30	1.35	1061	1070	WITS70	0.001	0.04	1
RWI550	6.58	6.92	0.34	6201	5.07	4.47	5050	5055	WITS70	0.008	0.04	2
RWI548	4.25	5.08	0.83	13444	4.50	3.55	331	340	WITS90_2	0.012	0.035	7
RWI546	4.83	5.00	0.17	5296	8.65	3.53	718	727	WITS90_3	0.009	0.035	3
RWI544	4.58	5.25	0.67	9910	4.11	2.74	638	646	WITS40	0.008	0.035	5
RWI540	4.83	4.92	0.09	4350	13.43	5.07	1025	1033	WITS90_1	0.017	0.035	1
R538A	4.92	5.58	0.66	18226	7.67	5.39	1467	1474	WITS90_2	0.013	0.035	8
RWI538	5.50	6.08	0.58	15096	7.23	4.51	2009	2016	WITS90_3	0.008	0.035	9
RWI534	4.33	4.58	0.25	3889	4.32	3.54	577	586	WITS90_3	0.011	0.035	2
R530*	4.58	5.25	0.67	14751	6.12	4.35	1600	1607	WITS90_3	0.008	0.035	9
RD544	4.58	5.17	0.59	9401	4.43	3.30	1354	1360	WITS40	0.008	0.035	6
RPI663	4.83	5.50	0.67	14316	5.94	4.78	428	437	PITS10_1	0.015	0.035	10
RPI660	5.33	5.50	0.17	5729	9.36	5.78	1157	1165	PITS10_1	0.013	0.035	2
RPI654 **	5.08	5.33	0.25	6847	7.61	6.08	2660	2668	PITS10_2	0.010	0.035	4
RPI651 **	5.17	5.42	0.25	5658	6.29	5.65	3757	3764	PITS10_2	0.007	0.035	3

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
R645A	4.75	5.08	0.33	8664	7.29	5.21	1151	1160	PITS10_2	0.012	0.035	5
RD654	5.08	5.58	0.50	11215	6.23	4.20	656	665	PITS10_2	0.010	0.035	6
RPI689	5.00	5.33	0.33	18798	15.82	10.76	6946	6951	WITS100	0.017	0.035	4
RPI687	5.33	5.50	0.17	10777	17.61	11.87	10057	10061	WITS100	0.017	0.035	2
RPI684	5.58	5.92	0.34	14047	11.48	10.02	9778	9780	WITS110_1	0.014	0.035	4
RPI681 **	5.92	6.50	0.58	19831	9.50	7.73	9568	9568	WITS110_2	0.011	0.035	7
RPI690 **	6.42	6.58	0.16	2826	4.91	4.32	7158	7162	WITS110_2	0.003	0.035	1
RD678	6.50	6.92	0.42	6108	4.04	3.65	2378	2385	WITS110_2	0.004	0.035	1
RWI542	7.42	7.58	0.16	2706	4.70	2.78	421	430	WITS90_3	0.007	0.035	1
RWI529	7.08	7.33	0.25	3670	4.08	2.61	600	608	WITS70	0.010	0.04	1
RWI516	6.92	7.67	0.75	11711	4.34	3.71	5000	5004	WITS70	0.005	0.04	6
RDCP07	7.42	7.83	0.41	6956	4.71	2.91	424	433	WITS120	0.008	0.035	2
RD529	7.08	7.50	0.42	4871	3.22	1.98	115	125	WITS130	0.008	0.035	1
RWI528	7.33	7.75	0.42	8240	5.45	2.63	884	892	WITS70	0.007	0.04	2
RDCPOT	7.42	8.08	0.66	8638	3.64	0.15	5	0	WITS70	0.007	0.04	2
RWI527	4.33	4.67	0.34	5909	4.83	2.45	749	758	WITS70	0.007	0.04	3
R508* **	7.75	8.33	0.58	12366	5.92	4.58	5106	5110	WITS130	0.005	0.035	7
R510A	4.33	5.42	1.09	17257	4.40	2.34	910	918	WITS70	0.005	0.04	8
RWI510	8.25	8.67	0.42	6492	4.29	3.48	4250	4254	WITS70	0.005	0.04	2
RWI502	8.25	8.33	0.08	1679	5.83	9.80	15765	15773	Channel	0.003	0.035	1
RDCP08	7.50	7.67	0.17	4229	6.91	3.26	415	424	WITS120	0.011	0.035	1
RWI526	7.17	8.00	0.83	11922	3.99	2.80	486	495	WITS120	0.007	0.035	6
RDCP09	7.42	8.25	0.83	14618	4.89	3.02	439	448	WITS120	0.009	0.035	8
RD527	4.33	5.00	0.67	7666	3.18	1.40	58	48	WITS130	0.007	0.035	2
RWI525	4.50	5.17	0.67	11015	4.57	3.46	1279	1286	WITS130	0.006	0.035	6
RD525	4.50	5.50	1.00	6496	1.80	1.51	72	62	WITS130	0.007	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RWI524	4.42	4.75	0.33	4526	3.81	3.03	802	810	WITS130	0.006	0.035	2
RWI506	5.00	5.25	0.25	5235	5.82	2.87	2474	2481	WITS70	0.004	0.04	3
RD508	8.33	8.58	0.25	5200	5.78	2.58	957	964	WITS70	0.007	0.04	2
RWI500	18.50	19.08	0.58	5659	2.71	3.99	2117	2127	Channel	0.001	0.035	3
RPI635	19.08	19.75	0.67	7557	3.13	3.99	2114	2123	Channel	0.001	0.035	6
RDCP11	7.42	7.75	0.33	6377	5.37	3.74	438	447	PITS10_2	0.009	0.035	5
RDCP12	7.42	7.75	0.33	6159	5.18	3.17	422	431	PITS30	0.009	0.035	2
RPI618	7.25	8.00	0.75	10443	3.87	3.26	490	499	PITS20	0.008	0.035	5
RDCP13	7.42	8.08	0.66	11034	4.64	3.13	439	448	PITS30	0.009	0.035	6
RD618	7.25	7.67	0.42	4541	3.00	3.57	557	565	PITS20	0.009	0.035	2
RPI615	7.67	7.92	0.25	5109	5.68	4.10	1130	1139	PITS20	0.008	0.035	2
RPI612	8.17	8.42	0.25	5754	6.39	2.77	357	366	PITS20	0.006	0.035	3
RDCP14 **	7.42	8.67	1.25	20386	4.53	2.98	378	387	PITS30	0.009	0.035	12
RPI609	4.75	4.92	0.17	4513	7.37	6.19	1277	1286	PITS40	0.006	0.035	2
RD612 **	8.17	8.75	0.58	11125	5.33	3.75	1058	1066	PITS20	0.007	0.035	8
RPI621	5.25	5.42	0.17	2775	4.53	3.81	1256	1264	TSR621	0.008	0.035	1
RDCP10	7.42	7.83	0.41	6701	4.54	2.92	451	460	WITS120	0.008	0.035	4
RPI628	7.25	8.17	0.92	14427	4.36	3.61	869	878	PITS20	0.007	0.035	6
R624A	4.75	5.58	0.83	11809	3.95	2.97	1824	1831	PDTS40_1	0.004	0.035	6
RD524	4.42	4.75	0.33	2235	1.88	0.72	25	15	WITS130	0.003	0.035	1
RPI639	4.50	5.17	0.67	5380	2.23	2.02	241	250	WITS130	0.005	0.035	2
RPI636 +	4.33	4.33	0.08	728	2.43	3.70	562	571	WITS130	0.014	0.035	1
RPI624 **	5.50	5.83	0.33	5060	4.26	3.53	2287	2293	TSR621	0.004	0.035	3
RPI633	15.75	16.33	0.58	5834	2.79	4.33	2830	2839	Channel	0.001	0.035	4
RDCP15	8.75	9.17	0.42	9602	6.35	3.11	327	336	PITS30	0.011	0.035	5
R606A	9.50	10.00	0.50	12583	6.99	2.72	233	242	PDTS30	0.008	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPI606	4.58	4.83	0.25	2654	2.95	2.56	830	839	TSR606	0.006	0.035	1
RD606A	9.50	9.83	0.33	7507	6.32	2.43	162	171	PITS30	0.009	0.035	4
RPI604	4.50	4.83	0.33	7442	6.26	3.07	462	471	PDTS30	0.007	0.035	3
RD600A	4.75	5.33	0.58	4775	2.29	1.91	1236	1245	TSBEAR	0.001	0.035	2
RPI603	5.17	5.42	0.25	3427	3.81	3.22	2340	2346	PDTS40_1	0.004	0.035	1
RPI600	15.08	15.58	0.50	4937	2.74	4.49	3214	3223	Channel	0.001	0.035	2
RDCP16	8.75	9.25	0.50	10754	5.97	4.60	1138	1145	PDTS30	0.011	0.035	8
RDCP17	8.83	9.08	0.25	10400	11.56	3.50	379	388	PDTS30	0.012	0.035	4
RPD740	9.42	9.75	0.33	5434	4.57	4.11	1697	1705	PDTS30	0.006	0.035	5
R726B	9.75	9.92	0.17	4094	6.69	4.54	1682	1689	PDTS30	0.008	0.035	2
RDCP18	8.83	9.25	0.42	14927	9.87	3.34	383	392	PDTS30	0.010	0.035	6
RPD736	6.08	6.17	0.09	1894	5.85	2.81	488	497	PDTS30	0.005	0.035	1
RDCP19	8.75	9.00	0.25	5902	6.56	5.13	1156	1163	PDTS30	0.015	0.035	4
RPD760	4.75	4.92	0.17	5149	8.41	3.40	408	417	PDTS30	0.010	0.035	2
RPD732	5.67	6.33	0.66	10623	4.47	3.86	1298	1307	PDTS30	0.006	0.035	6
R726A	6.17	6.33	0.16	3986	6.92	4.40	1902	1909	PDTS30	0.007	0.035	2
R726*	6.58	7.25	0.67	4179	1.73	4.62	3130	3136	PDTS30	0.006	0.035	2
RPD726	7.25	7.58	0.33	4959	4.17	3.25	2432	2437	PDTS40_1	0.004	0.035	2
RD744 +	0.00	0.00	0.08	3177	10.59	0.15	0	0	TSR606	0.006	0.035	1
RPD720	8.58	8.67	0.09	1840	5.68	11.67	5206	5214	Channel	0.010	0.035	1
RD716	7.25	7.50	0.25	4300	4.78	3.11	699	707	PDTS40_1	0.009	0.035	2
R700*	8.25	8.92	0.67	5757	2.39	5.21	5495	5503	Channel	0.001	0.035	2
RPD748	4.42	4.75	0.33	6476	5.45	4.78	525	534	PDTS40_2	0.015	0.035	3
RPD756	4.92	5.25	0.33	8775	7.39	6.17	1746	1754	PDTS40_2	0.013	0.035	4
R708*	5.00	5.42	0.42	10484	6.93	5.33	1956	1964	PDTS40_2	0.008	0.035	6
R712A	4.58	4.92	0.34	6448	5.27	4.06	535	544	PDTS40_2	0.009	0.035	6

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation

** Modified Typical X-Section

x Modified Time To Peak Used

Appendix D.3

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC **JOB NO.** 310.032

JOB: Wittmann Area Drainage Master Study Update

Storm: 100-yr, 6-hr Future Conditions **Route N-Step vs Velocity**

Route (Model Order)	Previous Time to Peak [hr]	Route Time to Peak [hr]	Difference in Time to peak [hr]	Route Length [ft]	HEC-1 Velocity [fps]	Normal Depth Velocity [fps]	HEC-1 Flow [cfs]	Normal Depth Flow [cfs]	Typical Cross Section	Route Slope [ft/ft]	Manning's "n" Value	HEC-1 N-step
RPD708	5.08	5.17	0.09	2780	8.58	3.94	3489	3495	PDTS40_1	0.006	0.035	1
RPD704	5.25	5.50	0.25	5924	6.58	3.92	3676	3681	PDTS40_1	0.006	0.035	4
RD800 +	0.00	0.00	0.08	5888	19.63	0.15	0	0	PDTS40_1	0.006	0.035	2
R810*	8.75	9.25	0.50	10685	5.94	4.45	5655	5659	PDTS40_1	0.006	0.035	8
RAF803	4.67	4.83	0.16	5287	9.18	4.47	1935	1944	TSAF10	0.002	0.035	2
RAF805	4.33	5.08	0.75	6821	2.53	2.59	639	648	PDTS40_1	0.006	0.035	6
RAF807 +	4.67	4.67	0.08	2485	8.28	6.53	2887	2896	TSAF10	0.004	0.035	1
RAF810	9.17	9.50	0.33	8372	7.05	5.11	5650	5651	PDTS40_1	0.008	0.035	3
RAF854	4.08	4.17	0.09	2113	6.52	4.78	796	805	TSAF10	0.005	0.035	1
RAF852	4.08	4.17	0.09	1378	4.25	5.24	1172	1181	TSAF10	0.004	0.035	1
RAF864	4.25	4.67	0.42	4666	3.09	1.78	67	57	TSAF20	0.003	0.035	1
RAF862	4.00	4.08	0.08	2136	7.42	3.99	441	450	TSAF20	0.005	0.035	1
RAF866	4.17	4.42	0.25	6743	7.49	4.32	634	643	TSAF20	0.004	0.035	1
RSV258	4.42	4.58	0.16	2155	3.74	3.68	487	495	TSR248	0.018	0.035	1

+ Time lapse less than time step of 5 minutes, so 1 time step was assumed for HEC-1 Velocity Calculation
** Modified Typical X-Section
x Modified Time To Peak Used

D.3.7 Routing Input Data Summary

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Route ID	Mannings' n-values Overbank	Channel	length [ft]	length [miles]	US elev [ft]	DS elev [ft]	slope [ft/ft]	Typical Cross Section ID
R150A	0.060	0.035	9557.0	1.81	1730.0	1530.0	0.0209	WTTS20_2
R205*	0.040	0.04	9517.3	1.80	1492	1412.0	0.0084	SVTS40
R230*	0.040	0.04	8744.1	1.66	1540	1462.0	0.0089	SVTS30
R242*	0.040	0.04	13351.2	2.53	1629.9	1497.7	0.0099	SVTS10
R264A	0.040	0.04	4041.9	0.77	1568	1556.0	0.0030	TSR264A
R350*	0.040	0.04	8309.6	1.57	1680	1630.0	0.0060	IWTS40_1
R359*	0.040	0.04	9280.3	1.76	1888	1792.0	0.0103	IWTS30_2
R390A	0.043	0.035	8577.0	1.62	2155	2040.0	0.0134	IWTS10_1
R442*	0.040	0.04	9087.7	1.72	1645.9	1581.3	0.0071	WITS20
R446A	0.043	0.035	6777.0	1.28	1758.0	1700.0	0.0086	WITS130
R450A	0.043	0.035	5936.0	1.12	2056.0	1968.0	0.0148	WITS10
R450B	0.043	0.035	18811.0	3.56	1968.0	1738.0	0.0122	WITS10
R452A	0.043	0.035	16523.0	3.13	2048.0	1816.0	0.0140	WITS10
R452B	0.043	0.035	9296.0	1.76	1816.0	1738.0	0.0084	WITS10
R508*	0.043	0.035	12365.6	2.34	1433.5	1367.6	0.0053	WITS130
R510A	0.040	0.04	17256.7	3.27	1460	1372.0	0.0051	WITS70
R530*	0.043	0.035	14750.6	2.79	1677.1	1556.3	0.0082	WITS90_3
R538A	0.043	0.035	18226.3	3.45	1912	1668.0	0.0134	WITS90_2
R562*	0.043	0.035	14580.6	2.76	1852	1688.0	0.0112	WITS40
R576A	0.043	0.035	8797.0	1.67	2044	1896.0	0.0168	WITS10
R576B	0.043	0.035	18394.4	3.48	1896	1686.0	0.0114	WITS10
R580A	0.043	0.035	21212.8	4.02	2024	1832.0	0.0091	WITS10
R580B	0.043	0.035	8181.3	1.55	2182	2016.0	0.0203	WITS10
R606A	0.043	0.035	12583.4	2.38	1454	1352.0	0.0081	PDTS30
R624A	0.043	0.035	11809.0	2.24	1392	1342.0	0.0042	PDTS40_1
R645A	0.043	0.035	8663.6	1.64	1656	1552.0	0.0120	PITS10_2
R700*	0.045	0.035	5757.0	1.09	1314	1308.0	0.0010	Channel
R708*	0.043	0.035	10483.6	1.99	1430	1348.0	0.0078	PDTS40_2
R712A	0.043	0.035	6448.0	1.22	1394	1334.9	0.0092	PDTS40_2
R726*	0.043	0.035	4179.0	0.79	1366	1342.0	0.0057	PDTS30
R726A	0.043	0.035	3986.0	0.75	1394	1366.0	0.0070	PDTS30
R726B	0.043	0.035	4094.0	0.78	1400	1366.0	0.0083	PDTS30
R810*	0.043	0.035	10685.0	2.02	1312	1250.0	0.0058	PDTS40_1
RAF803	0.045	0.035	5287.0	1.00	1270	1260.0	0.0019	TSAF10
RAF805	0.043	0.035	6821.0	1.29	1290	1250.0	0.0059	PDTS40_1
RAF807	0.045	0.035	2485.0	0.47	1260	1250.0	0.0040	TSAF10

Entellus

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Route ID	Mannings' n-values Overbank	Channel	length [ft]	length [miles]	US elev [ft]	DS elev [ft]	slope [ft/ft]	Typical Cross Section ID
RAF810	0.043	0.035	8372.0	1.59	1250	1180.0	0.0084	PDTS40_1
RAF852	0.045	0.035	1378.0	0.26	1154	1148.0	0.0044	TSAF10
RAF854	0.045	0.035	2113.0	0.40	1164	1154.0	0.0047	TSAF10
RAF862	0.045	0.035	2136.0	0.40	1128	1118.0	0.0047	TSAF20
RAF864	0.045	0.035	4666.0	0.88	1142	1128.0	0.0030	TSAF20
RAF866	0.045	0.035	6743.0	1.28	1148	1118.0	0.0044	TSAF20
RD248	0.040	0.04	4587.8	0.87	1740.5	1665.1	0.0164	SVTS10
RD312	0.043	0.035	1034.0	0.20	1908	1900.0	0.0077	WITS130
RD349	0.043	0.035	4244.0	0.80	1782.7	1735.5	0.0111	TWTS20
RD351	0.040	0.04	6586.0	1.25	1790	1740.0	0.0076	IWTS30_1
RD357	0.040	0.04	2791.0	0.53	1848	1826.0	0.0079	IWTS30_1
RD363	0.040	0.04	3820.0	0.72	1826	1790.0	0.0094	IWTS30_1
RD365	0.043	0.035	1700.0	0.32	1900	1882.0	0.0106	WITS130
RD369	0.043	0.035	1927.0	0.36	1884	1874.0	0.0052	WITS130
RD371	0.043	0.035	1409.0	0.27	1964	1962.0	0.0014	WITS130
RD372	0.043	0.035	1828.0	0.35	1824	1818.0	0.0033	WITS130
RD380	0.043	0.035	1142.0	0.22	2072	2068.0	0.0035	TWTS20
RD382A	0.043	0.035	1172.0	0.22	1952	1944.0	0.0068	WITS130
RD446A	0.043	0.035	2942.0	0.56	1764	1738.0	0.0088	WITS130
RD448	0.043	0.035	1591.0	0.30	1780	1760.0	0.0126	WITS130
RD450	0.043	0.035	2017.0	0.38	1738	1726.0	0.0059	WITS130
RD454	0.043	0.035	3342.0	0.63	1861.3	1816.0	0.0136	WITS90_2
RD482	0.043	0.035	2439.0	0.46	1650	1627.0	0.0094	WITS130
RD508	0.040	0.04	5200.0	0.98	1366	1332.2	0.0065	WITS70
RD524	0.043	0.035	2235.0	0.42	1382	1376.0	0.0027	WITS130
RD525	0.043	0.035	6496.0	1.23	1424	1382.0	0.0065	WITS130
RD527	0.043	0.035	7666.0	1.45	1474	1424.0	0.0065	WITS130
RD529	0.043	0.035	4871.0	0.92	1526	1488.0	0.0078	WITS130
RD544	0.043	0.035	9401.1	1.78	1628.8	1552.0	0.0082	WITS40
RD576	0.043	0.035	4830.3	0.91	1734	1688.0	0.0095	WITS10
RD576B	0.043	0.035	13551.5	2.57	1896	1736.0	0.0118	WITS10
RD580B	0.043	0.035	9429.7	1.79	2182	1994.0	0.0199	WITS90_1
RD600A	0.043	0.035	4775.0	0.90	1342	1336.0	0.0013	TSBEAR
RD606A	0.043	0.035	7506.5	1.42	1454	1389.0	0.0087	PITS30
RD612	0.043	0.035	11125.0	2.11	1412.2	1340.0	0.0065	PITS20
RD618	0.043	0.035	4541.0	0.86	1486	1446.0	0.0088	PITS20

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Route ID	Mannings' n-values Overbank	Channel	length [ft]	length [miles]	US elev [ft]	DS elev [ft]	slope [ft/ft]	Typical Cross Section ID
RD654	0.043	0.035	11214.8	2.12	1658	1548.4	0.0098	PITS10_2
RD678	0.043	0.035	6108.0	1.16	1574	1550.0	0.0039	WITS110_2
RD744	0.043	0.035	3177.0	0.60	1338	1320.0	0.0057	TSR606
RD800	0.043	0.035	5888.0	1.12	1346	1311.0	0.0059	PDTS40_1
RDCP07	0.043	0.035	6956.4	1.32	1552	1494.0	0.0083	WITS120
RDCP08	0.043	0.035	4229.1	0.80	1556	1508.0	0.0114	WITS120
RDCP09	0.043	0.035	14617.9	2.77	1558	1426.0	0.0090	WITS120
RDCP10	0.043	0.035	6701.3	1.27	1550	1496.0	0.0081	WITS120
RDCP11	0.043	0.035	6376.9	1.21	1550	1490.0	0.0094	PITS10_2
RDCP12	0.043	0.035	6159.0	1.17	1548.4	1490.7	0.0094	PITS30
RDCP13	0.043	0.035	11034.4	2.09	1544	1446.0	0.0089	PITS30
RDCP14	0.043	0.035	20385.8	3.86	1556	1380.0	0.0086	PITS30
RDCP15	0.043	0.035	9601.8	1.82	1556	1454.0	0.0106	PITS30
RDCP16	0.043	0.035	10753.8	2.04	1556	1436.0	0.0112	PDTS30
RDCP17	0.043	0.035	10399.9	1.97	1556	1436.0	0.0115	PDTS30
RDCP18	0.043	0.035	14927.0	2.83	1556	1406.0	0.0100	PDTS30
RDCP19	0.043	0.035	5902.3	1.12	1552	1464.0	0.0149	PDTS30
RDCPOT	0.040	0.04	8638.0	1.64	1538	1474.0	0.0074	WITS70
RIW300	0.040	0.04	6125.0	1.16	1445.1	1418.8	0.0043	TWTS50
RIW302	0.040	0.04	5720.1	1.08	1443.9	1418.8	0.0044	TWTS50
RIW310	0.040	0.04	860.0	0.16	1548.7	1547.0	0.0020	IWTS50
RIW312	0.040	0.04	8292.4	1.57	1908.3	1828.3	0.0096	TSR375
RIW314	0.040	0.04	20067.8	3.80	1547	1445.1	0.0051	IWTS50
RIW318	0.040	0.04	17570.2	3.33	1634.9	1548.7	0.0049	TSR294
RIW322	0.040	0.04	12886.2	2.44	1616.3	1547.0	0.0054	IWTS40_2
RIW326	0.040	0.04	8065.9	1.53	1594.9	1548.7	0.0057	TWTS30
RIW330	0.040	0.04	2770.8	0.52	1630.4	1616.3	0.0051	IWTS40_2
RIW334	0.040	0.04	21501.4	4.07	1588.6	1443.9	0.0067	TWTS40
RIW338	0.040	0.04	7227.0	1.37	1588.6	1548.7	0.0055	TWTS30
RIW346	0.040	0.04	3705.8	0.70	1605.5	1588.6	0.0046	TWTS30
RIW349	0.043	0.035	4331.4	0.82	1782.7	1712.9	0.0161	TWTS20
RIW351	0.040	0.04	24311.3	4.60	1791.5	1606.6	0.0076	IWTS30_2
RIW353	0.040	0.04	7495.9	1.42	1720	1680.0	0.0053	IWTS40_1
RIW354	0.040	0.04	4522.5	0.86	1712.9	1680.3	0.0072	TSR371
RIW356	0.040	0.04	2643.0	0.50	1735.5	1712.9	0.0086	TSR371
RIW357	0.040	0.04	16692.7	3.16	1848	1716.8	0.0079	IWTS30_1

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RIW359	0.040	0.04	13031.3	2.47	1793.4	1716.8	0.0059	IWTS30_2
RIW360	0.043	0.035	2593.3	0.49	1756	1735.5	0.0079	TWTS20
RIW361	0.040	0.04	17152.4	3.25	1740	1630.0	0.0064	IWTS30_1
RIW363	0.040	0.04	11126.8	2.11	1826	1740.0	0.0077	IWTS30_1
RIW364	0.040	0.04	10401.5	1.97	1682.4	1605.5	0.0074	TSR371
RIW365	0.040	0.04	7350.8	1.39	1893.6	1828.3	0.0089	IWTS30_1
RIW366	0.040	0.04	9656.7	1.83	1864	1796.0	0.0070	IWTS30_2
RIW368	0.040	0.04	11647.7	2.21	1875.5	1756.0	0.0103	TSR375
RIW369	0.040	0.04	6796.8	1.29	1887.1	1828.3	0.0087	TSR375
RIW370	0.043	0.035	7247.6	1.37	1851.8	1782.7	0.0095	TWTS20
RIW371	0.040	0.04	11583.3	2.19	1965.7	1864.0	0.0088	TSR371
RIW372	0.040	0.04	15366.7	2.91	1828	1680.0	0.0096	TSR375
RIW374	0.040	0.04	20436.7	3.87	1962	1796.0	0.0081	TSR371
RIW375	0.040	0.04	13330.0	2.52	1814	1681.5	0.0099	TSR375
RIW377	0.040	0.04	6588.4	1.25	2025.8	1962.6	0.0096	TSR371
RIW380	0.043	0.035	16914.1	3.20	2072.5	1851.8	0.0130	TWTS20
RIW381	0.040	0.04	4964.3	0.94	1939.5	1892.0	0.0096	TSR371
RIW382	0.040	0.04	4964.3	0.94	1947.8	1888.0	0.0120	TSR371
RIW384	0.040	0.04	4694.3	0.89	1940	1882.0	0.0124	TSR371
RIW386	0.043	0.035	10311.1	1.95	2027.8	1947.8	0.0078	IWTS20_1
RIW387	0.043	0.035	1005.1	0.19	2179.3	2165.2	0.0140	TWTS20
RIW388	0.040	0.04	7725.8	1.46	1920.8	1848.0	0.0094	IWTS20_2
RIW389	0.040	0.04	11459.2	2.17	2063.1	1920.8	0.0124	TSR371
RIW390	0.043	0.035	11625.6	2.20	2038.3	1920.8	0.0101	IWTS20_1
RIW394	0.043	0.035	7697.0	1.46	2257	2155.0	0.0133	IWTS10_1
RIW395	0.043	0.035	13324.0	2.52	2389.6	2165.2	0.0168	TWTS10
RIW396	0.043	0.035	6512.2	1.23	2165.2	2072.5	0.0142	TWTS10
RIW397	0.043	0.035	21294.0	4.03	2830	2390.0	0.0207	TWTS10
RPD704	0.043	0.035	5924.4	1.12	1334.9	1302.6	0.0055	PDTS40_1
RPD708	0.043	0.035	2780.0	0.53	1351	1334.9	0.0058	PDTS40_1
RD716	0.043	0.035	4300.0	0.81	1341.9	1302.6	0.0091	PDTS40_1
RPD720	0.045	0.035	1840.0	0.35	1320.9	1302.6	0.0099	Channel
RPD726	0.043	0.035	4959.0	0.94	1342	1320.0	0.0044	PDTS40_1
RPD732	0.043	0.035	10623.0	2.01	1464	1396.0	0.0064	PDTS30
RPD736	0.043	0.035	1894.0	0.36	1406	1396.0	0.0053	PDTS30
RPD740	0.043	0.035	5434.0	1.03	1436	1402.0	0.0063	PDTS30

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RPD748	0.043	0.035	6476.1	1.23	1524	1430.0	0.0145	PDTS40_2
RPD756	0.043	0.035	8775.3	1.66	1540	1430.0	0.0125	PDTS40_2
RPD760	0.043	0.035	5148.6	0.98	1516	1464.0	0.0101	PDTS30
RPI600	0.045	0.035	4937.0	0.94	1318	1320.9	0.0010	Channel
RPI603	0.043	0.035	3427.5	0.65	1337.5	1322.4	0.0044	PDTS40_1
RPI604	0.043	0.035	7441.8	1.41	1390	1338.0	0.0070	PDTS30
RPI606	0.043	0.035	2654.4	0.50	1352.2	1337.5	0.0055	TSR606
RPI609	0.043	0.035	4513.0	0.85	1372	1344.0	0.0062	PITS40
RPI612	0.043	0.035	5753.6	1.09	1412.2	1377.5	0.0060	PITS20
RPI615	0.043	0.035	5108.7	0.97	1452.4	1412.2	0.0079	PITS20
RPI618	0.043	0.035	10443.1	1.98	1490.7	1412.2	0.0075	PITS20
RPI621	0.043	0.035	2775.0	0.53	1342	1320.0	0.0079	TSR621
RPI624	0.043	0.035	5060.0	0.96	1342	1320.0	0.0043	TSR621
RPI628	0.043	0.035	14427.0	2.73	1488	1392.0	0.0067	PITS20
RPI633	0.045	0.035	5834.0	1.10	1322	1318.0	0.0010	Channel
RPI635	0.045	0.035	7557.0	1.43	1326	1322	0.0010	Channel
RPI636	0.043	0.035	728.0	0.14	1350	1340.0	0.0137	WITS130
RPI639	0.043	0.035	5380.0	1.02	1375.8	1350.0	0.0048	WITS130
RPI651	0.043	0.035	5658.2	1.07	1587	1548.4	0.0068	PITS10_2
RPI654	0.043	0.035	6846.6	1.30	1658	1587.0	0.0104	PITS10_2
RPI660	0.043	0.035	5729.3	1.09	1731	1658.0	0.0127	PITS10_1
RPI663	0.043	0.035	14315.6	2.71	1945	1731.0	0.0149	PITS10_1
RPI681	0.043	0.035	19831.2	3.76	1786	1568.0	0.0110	WITS110_2
RPI684	0.043	0.035	14047.0	2.66	1980	1784.5	0.0139	WITS110_1
RPI687	0.043	0.035	10777.1	2.04	2160	1980.0	0.0167	WITS100
RPI689	0.043	0.035	18798.3	3.56	2485	2160.0	0.0173	WITS100
RPI690	0.043	0.035	2826.0	0.54	1568	1560.0	0.0028	WITS110_2
RSV200	0.040	0.04	5688.5	1.08	1418.8	1392.1	0.0047	TWTS50
RSV202	0.040	0.04	6617.4	1.25	1447.9	1418.8	0.0044	TWTS50
RSV203	0.040	0.04	7460.7	1.41	1481.9	1418.8	0.0085	SVTS40
RSV210	0.040	0.04	12155.7	2.30	1504.5	1418.8	0.0071	SVTS40
RSV212	0.040	0.04	9921.7	1.88	1462	1412.0	0.0050	TSR408
RSV216	0.040	0.04	7196.1	1.36	1528.3	1497.7	0.0043	SVTS10
RSV218	0.040	0.04	4697.9	0.89	1546.5	1528.3	0.0039	SVTS10
RSV219	0.040	0.04	5058.3	0.96	1567.8	1546.5	0.0042	SVTS10
RSV220	0.040	0.04	10623.1	2.01	1502	1462.0	0.0038	SVTS50_2

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RSV236	0.040	0.04	9733.5	1.84	1528.2	1497.7	0.0031	SVTS20_1
RSV244	0.040	0.04	11106.1	2.10	1633.7	1528.3	0.0095	SVTS10
RSV248	0.060	0.035	7772.3	1.47	1740.5	1633.7	0.0137	TSR248
RSV250	0.040	0.04	11764.9	2.23	1674	1546.5	0.0108	SVTS10
RSV251	0.040	0.04	12592.4	2.38	1674.9	1546.5	0.0102	SVTS10
RSV252	0.040	0.04	9743.8	1.85	1659.5	1567.8	0.0094	SVTS10
RSV254	0.040	0.04	10928.0	2.07	1677.3	1567.8	0.0100	SVTS10
RSV258	0.060	0.035	2154.8	0.41	1744.2	1705.3	0.0181	TSR248
RSV260	0.040	0.04	6945.8	1.32	1536.5	1502.2	0.0049	SVTS50_1
RSV264	0.040	0.04	4870.0	0.92	1552	1538.0	0.0029	TSR264A
RSV268	0.040	0.04	2945.7	0.56	1540.7	1536.5	0.0014	SVTS50_1
RSV272	0.040	0.04	1627.9	0.31	1570.4	1560.7	0.0060	SVTS50_1
RSV276	0.040	0.04	1015.5	0.19	1560.7	1556.4	0.0042	SVTS50_1
RSV280	0.040	0.04	6287.6	1.19	1556.4	1536.5	0.0032	SVTS50_1
RSV284	0.040	0.04	12013.1	2.28	1646.8	1570.4	0.0064	TSR294
RSV286	0.040	0.04	3543.8	0.67	1668.2	1646.8	0.0060	TSR294
RSV290	0.040	0.04	13499.8	2.56	1654.9	1570.4	0.0063	TSR294
RSV294	0.040	0.04	14316.0	2.71	1650.4	1560.7	0.0063	TSR294
RSV298	0.040	0.04	15128.8	2.87	1647.5	1556.4	0.0060	TSR294
RTW400	0.045	0.035	6826.5	1.29	1359.4	1334.4	0.0037	Channel
RTW402	0.045	0.035	2374.6	0.45	1337.4	1359.4	0.0010	Channel
RTW404	0.045	0.035	2936.4	0.56	1334.3	1337.4	0.0010	Channel
RTW406	0.040	0.04	14969.5	2.84	1451.2	1334.3	0.0078	TSR408
RTW408	0.040	0.04	16567.5	3.14	1453.3	1334.3	0.0072	TSR408
RTW410	0.040	0.04	11702.6	2.22	1392.1	1337.4	0.0047	TWTS50
RTW414	0.040	0.04	10139.1	1.92	1467.2	1392.1	0.0074	TSR408
RTW416	0.040	0.04	18065.4	3.42	1483.7	1390.6	0.0052	WITS30
RTW418	0.040	0.04	7044.4	1.33	1484.7	1444.3	0.0057	WITS30
RTW420	0.040	0.04	12733.0	2.41	1450.8	1390.6	0.0047	WITS30
RTW422	0.040	0.04	22820.9	4.32	1444.3	1359.4	0.0037	WITS30
RTW424	0.040	0.04	5625.3	1.07	1473.7	1444.3	0.0052	WITS30
RTW429	0.040	0.04	3702.9	0.70	1552	1550.0	0.0010	TSR429
RTW430	0.040	0.04	10140.7	1.92	1546	1488.0	0.0057	WITS30
RTW432	0.040	0.04	8990.1	1.70	1640.0	1584.0	0.0062	TWTS30
RTW434	0.040	0.04	7363.4	1.39	1581.3	1547.6	0.0046	TWTS30
RTW436	0.040	0.04	13449.0	2.55	1615.6	1547.6	0.0051	TWTS30

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RTW444	0.040	0.04	2739.1	0.52	1671.6	1646.4	0.0092	WITS20
RTW446	0.040	0.04	6940.6	1.31	1700.0	1640.0	0.0086	WITS20
RTW448	0.043	0.035	8794.0	1.67	1782.0	1698.3	0.0095	WITS10
RTW450	0.043	0.035	7274.1	1.38	1737.3	1671.6	0.0090	WITS10
RTW452	0.040	0.04	8151.0	1.54	1726.4	1645.9	0.0099	WITS20
RTW454	0.043	0.035	13092.9	2.48	1861.3	1726.4	0.0103	WITS10
RTW456	0.043	0.035	4821.2	0.91	1919.3	1861.3	0.0120	WITS10
RTW458	0.043	0.035	3227.4	0.61	1962.8	1919.3	0.0135	WITS10
RTW459	0.043	0.035	6625.0	1.25	2056.0	1968.0	0.0133	TWTS20
RTW460	0.043	0.035	4935.1	0.93	2044.9	1962.8	0.0166	WITS10
RTW462	0.043	0.035	6520.0	1.23	2056.0	1968.0	0.0135	TWTS20
RTW478	0.040	0.04	5968.5	1.13	1554	1546.0	0.0013	TSR478
RTW480	0.040	0.04	4817.3	0.91	1591.9	1552.0	0.0083	TSR482
RTW482	0.040	0.04	7471.3	1.42	1650.2	1591.9	0.0078	TSR482
RTW484	0.040	0.04	10402.1	1.97	1680	1591.9	0.0085	TSR482
RTW485	0.040	0.04	1831.1	0.35	1686	1674.0	0.0066	TSR482
RWI500	0.045	0.035	5659.1	1.07	1332.2	1338.7	0.0010	Channel
RWI502	0.045	0.035	1679.3	0.32	1336.5	1332.2	0.0026	Channel
RWI504	0.045	0.035	1494.1	0.28	1334.4	1336.5	0.0010	Channel
RWI506	0.040	0.04	5234.7	0.99	1358.000	1336.0	0.0042	WITS70
RWI510	0.040	0.04	6491.7	1.23	1367.6	1336.5	0.0048	WITS70
RWI516	0.040	0.04	11711.2	2.22	1488.3	1428.2	0.0051	WITS70
RWI524	0.043	0.035	4525.7	0.86	1384	1356.0	0.0062	WITS130
RWI525	0.043	0.035	11015.0	2.09	1426	1356.0	0.0064	WITS130
RWI526	0.043	0.035	11922.1	2.26	1508.6	1426.8	0.0069	WITS120
RWI527	0.040	0.04	5909.0	1.12	1474	1434.0	0.0068	WITS70
RWI528	0.040	0.04	8239.6	1.56	1494	1434.0	0.0073	WITS70
RWI529	0.040	0.04	3669.9	0.70	1526	1490.0	0.0098	WITS70
RWI534	0.043	0.035	3888.5	0.74	1720.5	1677.1	0.0112	WITS90_3
RWI538	0.043	0.035	15096.4	2.86	1669.3	1556.3	0.0075	WITS90_3
RWI540	0.043	0.035	4350.4	0.82	1981.5	1908.0	0.0169	WITS90_1
RWI542	0.043	0.035	2705.6	0.51	1546	1526.0	0.0074	WITS90_3
RWI544	0.043	0.035	9910.1	1.88	1628.8	1546.5	0.0083	WITS40
RWI546	0.043	0.035	5296.4	1.00	1677.2	1628.8	0.0091	WITS90_3
RWI548	0.043	0.035	13443.6	2.55	1834.6	1677.2	0.0117	WITS90_2
RWI550	0.040	0.04	6201.4	1.17	1542	1490.0	0.0084	WITS70

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RWI552	0.040	0.04	1732.0	0.33	1564.6	1543.4	0.0122	WITS70
RWI554	0.043	0.035	4537.9	0.86	1607	1543.4	0.0140	WITS50
RWI556	0.043	0.035	11635.1	2.20	1692	1606.0	0.0074	WITS40
RWI560	0.043	0.035	11698.6	2.22	1688	1606.0	0.0070	WITS40
R560A	0.043	0.035	16408.0	3.11	1876	1688.0	0.0115	WITS10
RWI564	0.043	0.035	9364.4	1.77	1964	1852.0	0.0120	WITS90_1
RWI566	0.043	0.035	10390.3	1.97	1980	1852.0	0.0123	WITS90_1
RWI570	0.043	0.035	12212.1	2.31	1992	1822.0	0.0139	WITS90_1
RWI572	0.043	0.035	23542.7	4.46	1976	1688.0	0.0122	WITS90_1
RWI574	0.043	0.035	14010.4	2.65	1836	1688.0	0.0106	WITS10
RWI576	0.043	0.035	8726.4	1.65	1736	1650.2	0.0098	WITS10
RWI578	0.043	0.035	12423.9	2.35	1996	1832.0	0.0132	WITS90_1
RWI580	0.043	0.035	8541.2	1.62	1832	1736.0	0.0112	WITS10
RWI582	0.043	0.035	5153.1	0.98	1633.8	1607.0	0.0052	WITS10
RWI584	0.040	0.04	1409.2	0.27	1552	1552.0	0.0010	WITS70
RWT100	0.045	0.035	4778.0	0.90	1337	1335.2	0.0010	Channel
RWT110	0.045	0.035	7640.0	1.45	1339.8	1337.0	0.0010	Channel
RWT120	0.045	0.035	6167.9	1.17	1339.1	1339.8	0.0010	Channel
RWT130	0.045	0.035	5750.0	1.09	1341.7	1339.1	0.0010	Channel
RWT140	0.060	0.035	13052.8	2.47	1600	1350.0	0.0192	WTTS20_1
RWT150	0.060	0.035	16082.2	3.05	1553.5	1339.1	0.0133	WTTS20_1
RWT160	0.060	0.035	18961.0	3.59	1558.2	1339.1	0.0116	WTTS10_1

D.4. Storage Routing Data

D.4.1. CAP Canal

D.4.2. Beardsley Canal

D.4.3 SR 74

D.4.1. CAP Canal

APPENDIX D.4.1

CAP STORAGE ROUTING DATA

Flow Calculations:

In calculating the stage discharge at the CAP canal, Federal Highway Administration (FHA) nomograph, Chart 1 was utilized for the culverts. Various stages were chosen up to and including the berm elevation as determined from the mapping. In addition, calculations were made for the potential overtopping of the CAP Canal. The structure inverts were taken from the Wittmann ADMP CAP Canal Structure Surveys **(Reference 13)** report. The storage areas were computed based upon the contours and the storage volumes were estimated using the Conic Method for Reservoir Volumes as described by the HEC-1 program **(Reference 28)**.

The stage discharge relationship was calculated differently for the overchutes. Since these wide rectangular overchutes are relatively long, it was assumed that the flow will pass through critical depth at some point along the overchute. Based on this assumption the Froude number at critical depth is defined as follows:

$$Fr = 1 = \frac{BQ^2}{gA_c^3}$$

where:

B = Overchute Width
Q = Flow (cfs)
g = Gravity (ft/s^2)
A_c = Cross Sectional Area (ft^2)

This can be rearranged to yield:

$$Q = \left[\frac{gA_c^3}{B}\right]^{1/2}$$

The iterative process of calculating the flow begins by assuming a critical Y_c of some value, calculating the area ($A_c = Y_c * B$) and then solving for the flow. Then a check is performed to make sure that the assumed Y_c was correct for the given stage. The velocity head is calculated as follows:

$$\frac{V^2}{2g} = \left(\frac{Q}{A_c}\right)^2 * \frac{1}{2g}$$

It is assumed that there is no energy loss as the flow crosses the overchute. Based on this, the check is simply a conservation of energy equation where the Y_c is specific to the ponding stage. The check becomes: Stage = Invert Elevation + $Y_c + V^2/2g$. If this stage does not match the desired stage, a new value of Y_c must be assumed and the process repeated. This iterative process was used to compute the critical depths for various stages using the Critical Depth/ Energy Calculations spreadsheets that are included in this appendix. An example of the energy calculations for CAP 010 has been included as well.

For overtopping at the CAP Canal, the weir equation was utilized.

$$Q_{weir} = C * B * H^{3/2}$$

where:

C=Weir Coefficient
B=Weir Length
H=Water Depth Over Weir

A weir coefficient of 2.7 was assumed for all weirs, and the weir length was assumed to be the berm length where overtopping would occur. In the situation of overtopping, the flow was calculated for culvert flow as well as weir flow, and the total flow was the summation of the two.

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BY	RAS	DATE	9/08/2003
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JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Structure: CAP 010

Invert Elevation = 1537.52

Width (B) = 67'

Equations:

$$Q = \left[\frac{gA_c^3}{B}\right]^{1/2}$$

$$A = Y_c * B$$

$$\frac{V^2}{2g} = \left(\frac{Q}{A}\right)^2 * \frac{1}{2g}$$

$$Stage = Invert + Y_c + \frac{V^2}{2g}$$

Storage at 1538:

Assume $Y_c = 0.32'$

$A = 0.32'*67' = 21.44\ ft^2$

$Q = ((21.44^3 * 32.2)/67')^{1/2} = 68.82$ cfs

$V^2/2g = (68.82/21.44)^2*(1/(2*32.2)) = 0.16'$

Stage = 1537.52 + 0.32 + 0.16 =1538.0

Since the final stage matches the assumed stage of 1538 the assumed Y_c of 0.32' was correct. If a discrepancy existed another value of Y_c would be chosen and the calculations would be repeated until the calculated stage matches the assumed stage.

Storage at 1540:

Assume $Y_c = 1.65'$

$A = 1.65 * 67' = 110.77\ ft^2$

$Q = ((110.77^3 * 32.2)/67')^{1/2} = 808.25$ cfs

$V^2/2g = (808.25/110.77)^2*(1/(2*32.2)) = 0.83'$

Stage = 1537.52 + 0.83 + 1.65 =1540.0

So the assumed Y_c of 1.65' was correct for the stage of 1540.

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JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Structure: CAP 010

Invert Elevation = 1537.52

Width (B) = 67'

Storage at 1542:

Assume $Y_c = 2.99'$

$A = 2.99'*67' = 200.11\ ft^2$

$Q = ((200.11^3 * 32.2)/67')^{1/2} = 1962.38$ cfs

$V^2/2g = (1962.38/200.11)^2*(1/(2*32.2)) = 1.49'$

Stage = 1537.52 + 1.49 + 2.99 = 1542.0

So the assumed Y_c of 2.99' was correct for the stage of 1542.

Storage at 1546:

Assume $Y_c = 5.65'$

$A = 5.65'*67' = 378.77\ ft^2$

$Q = ((378.77^3 * 32.2)/67')^{1/2} = 5110.46$ cfs

$V^2/2g = (5110.46/378.77)^2*(1/(2*32.2)) = 2.83'$

Stage = 1537.52 + 2.83 + 5.65 = 1546.0

So the assumed Y_c of 5.65' was correct for the stage of 1546.

Storage at 1546.2:

Assume $Y_c = 5.79'$

$A = 5.79'*67' = 387.65\ ft^2$

$Q = ((387.65^3 * 32.2)/67')^{1/2} = 5291.15$ cfs

$V^2/2g = (5291.15/387.65)^2*(1/(2*32.2)) = 2.89'$

Stage = 1537.52 + 2.89 + 5.79 + = 1546.2

So the assumed Y_c of 5.79' was correct for the stage of 1546.2.

Storage Volume Calculations:

The storage volume calculations were performed using the Conic Method for Reservoir Volumes as described by the HEC-1 program **(Reference 28)**. Contours were used to first calculate the area at given elevations, 1540, 1542… etc, using AutoCAD. Due to the nature of the natural landscape there are many depressions and rises along the impoundment area of the CAP Canal. These additional areas were included or excluded from the storage area as appropriate thus adjusting the storage area. The areas (sq ft) were then converted to acres. The Conic Method was then applied to estimate the change in storage volume. It was assumed that the contour below the lowest estimated storage area elevation was the zero area and zero volume contour. This was necessary to calculate the lowest stage storage volume. For example if the lowest contour that would pond was 1530, and the mapping was in 2-foot contours, 1528 would be assumed to have zero storage area and zero storage volume. Linear interpolations were made for the invert elevations and top of berm elevations since contours were not available at most of those specific elevations. To estimate the top of berm storage area and volume, one contour higher than the berm was calculated (area and volume) assuming that the Canal was the boundary of the contour and linear interpolation was again used. Details of these calculations can be found in the following table.

APPENDIX D.4

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JOB NO.	310.032		

CLIENT: FCDMC

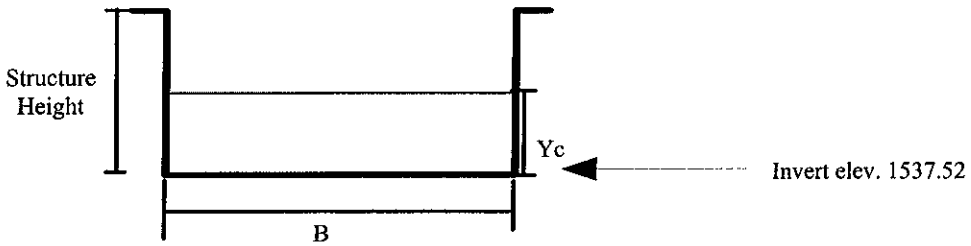
JOB: Wittmann Area Drainage Master Study Update

Structure: CAP 010, Reach 8 Sta. 466+00

CRITICAL DEPTH/ ENERGY CALCULATIONS

LOCATION CAP 010

Bottom Width =	67	(ft)
Left side Slope =	0	:1
Rigth Side Slopes =	0	:1
Invert Elevation=	1537.52	(ft)
Berm Elevation=	1546.2	(ft)



Stage (ft)	Critical Depth yc (ft)	Bottom Width B (ft)	Area A (ft^2)	Velocity Head (ft)	Discharge (cfs)	Storage Area (ac)
1530.0	0.00	67.00	0.00	0.00	0.00	0.10
1532.0	0.00	67.00	0.00	0.00	0.00	0.25
1534.0	0.00	67.00	0.00	0.00	0.00	0.47
1536.0	0.00	67.00	0.00	0.00	0.00	1.86
1537.5	0.00	67.00	0.00	0.00	0.00	9.86
1538.0	0.32	67.00	21.44	0.16	68.82	12.53
1540.0	1.65	67.00	110.77	0.83	808.25	26.53
1542.0	2.99	67.00	200.11	1.49	1962.38	59.20
1544.0	4.32	67.00	289.44	2.16	3413.72	117.50
1546.0	5.65	67.00	378.77	2.83	5110.46	183.97
1546.2	5.79	67.00	387.65	2.89	5291.15	191.94

Note: Elevations obtained from survey report. Storage areas estimated using topographic maps

APPENDIX D.4

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BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

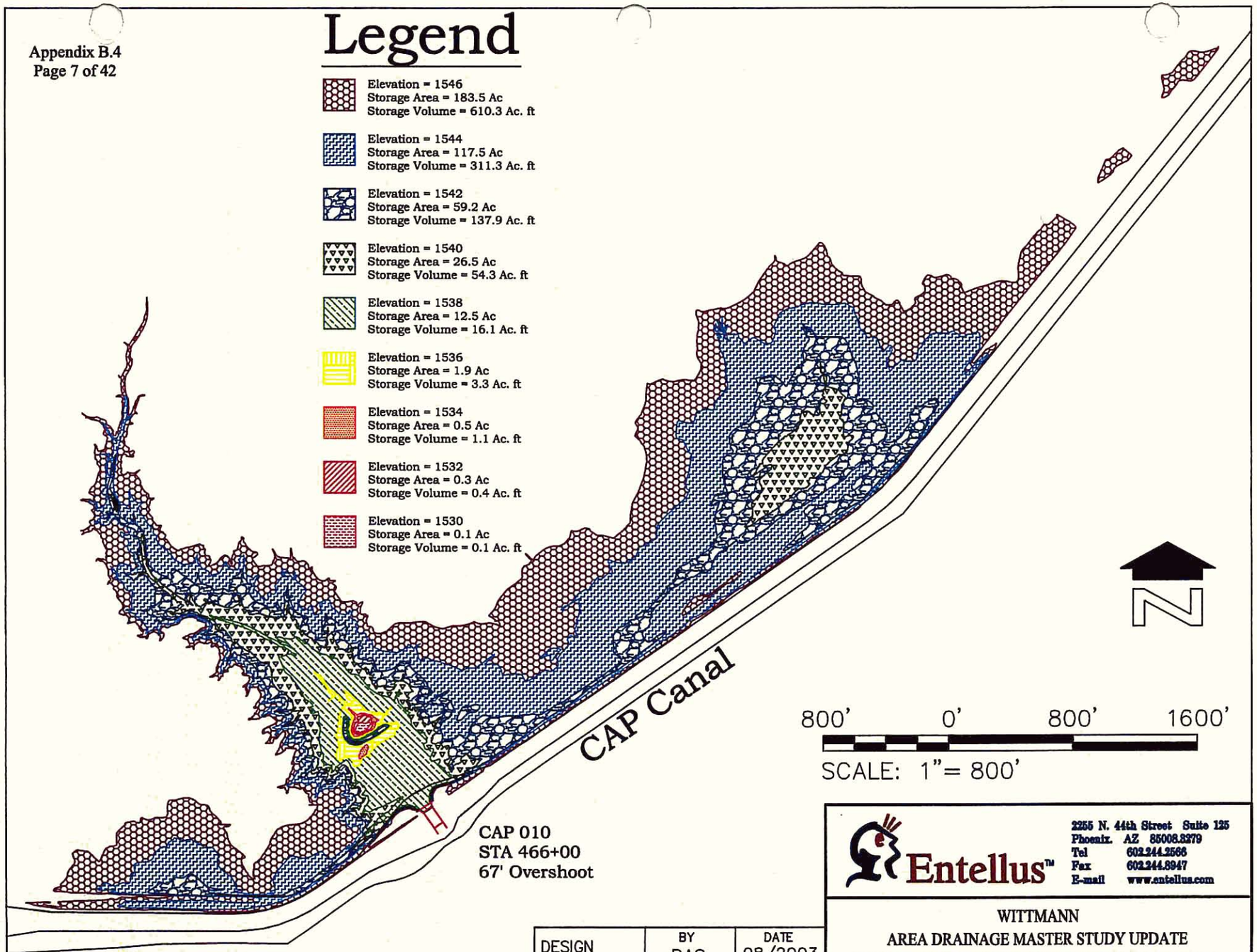
CAP Overchute Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: CAP 010

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1530	0	0.1	0.0	0
1532	2	0.3	0.3	0
1534	2	0.5	1.0	0
1536	2	1.9	3.2	0
1537	1	9.9	8.5	0
1538	1	12.5	19.7	68.82
1540	2	26.5	57.9	808.25
1542	2	59.2	141.4	1962.38
1544	2	117.5	314.6	3413.72
1546	2	184.0	613.3	5110.46
1546.2	0.2	191.9	650.8	5291.15

*Discharge calculated energy method

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)



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DESIGN CHK.	CJL	08/2003

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SHEET 8 OF 42

BY RAS DATE 19-Apr-04

CLIENT: FCDMC CHECK JS DATE 19-Apr-04

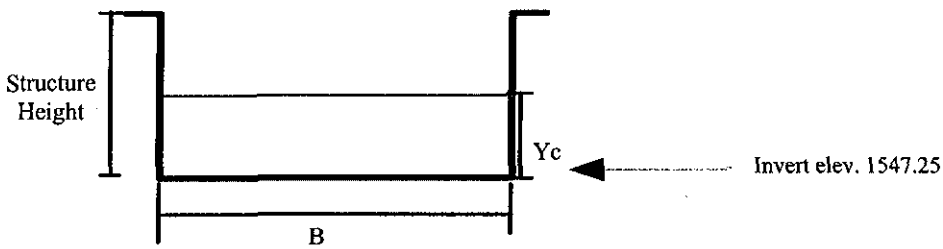
JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Structure: CAP 020, Reach 8 Sta. 572+50

CRITICAL DEPTH/ ENERGY CALCULATIONS

LOCATION CAP 020

Bottom Width =	47	(ft)
Left side Slope =	0	:1
Rigth Side Slopes =	0	:1
Invert Elevation=	1547.25	(ft)
Berm Elevation=	1553	(ft)



Stage (ft)	Critical Depth yc (ft)	Bottom Width B (ft)	Area A (ft^2)	Velocity Head (ft)	Discharge (cfs)	Storage Area (ac)
1546.0	0.00	47.00	0.00	0.00	0.00	5.50
1547.3	0.00	47.00	0.00	0.00	0.00	13.56
1548.0	0.50	47.00	23.50	0.25	94.29	17.90
1550.0	1.83	47.00	86.17	0.92	662.05	67.00
1552.0	3.17	47.00	148.83	1.58	1502.90	99.20
1553.0	3.83	47.00	180.17	1.92	2001.76	118.26
1554.0	4.50	47.00	211.50	2.25	2545.92	118.26

Note: Elevations obtained from survey report. Storage areas estimated using topographic maps

APPENDIX D.4

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JOB: Wittmann Area Drainage Master Study Update

CAP Overchute Discharge vs Water Surface Elevation/ Storage Area
Location/ Description: CAP 020

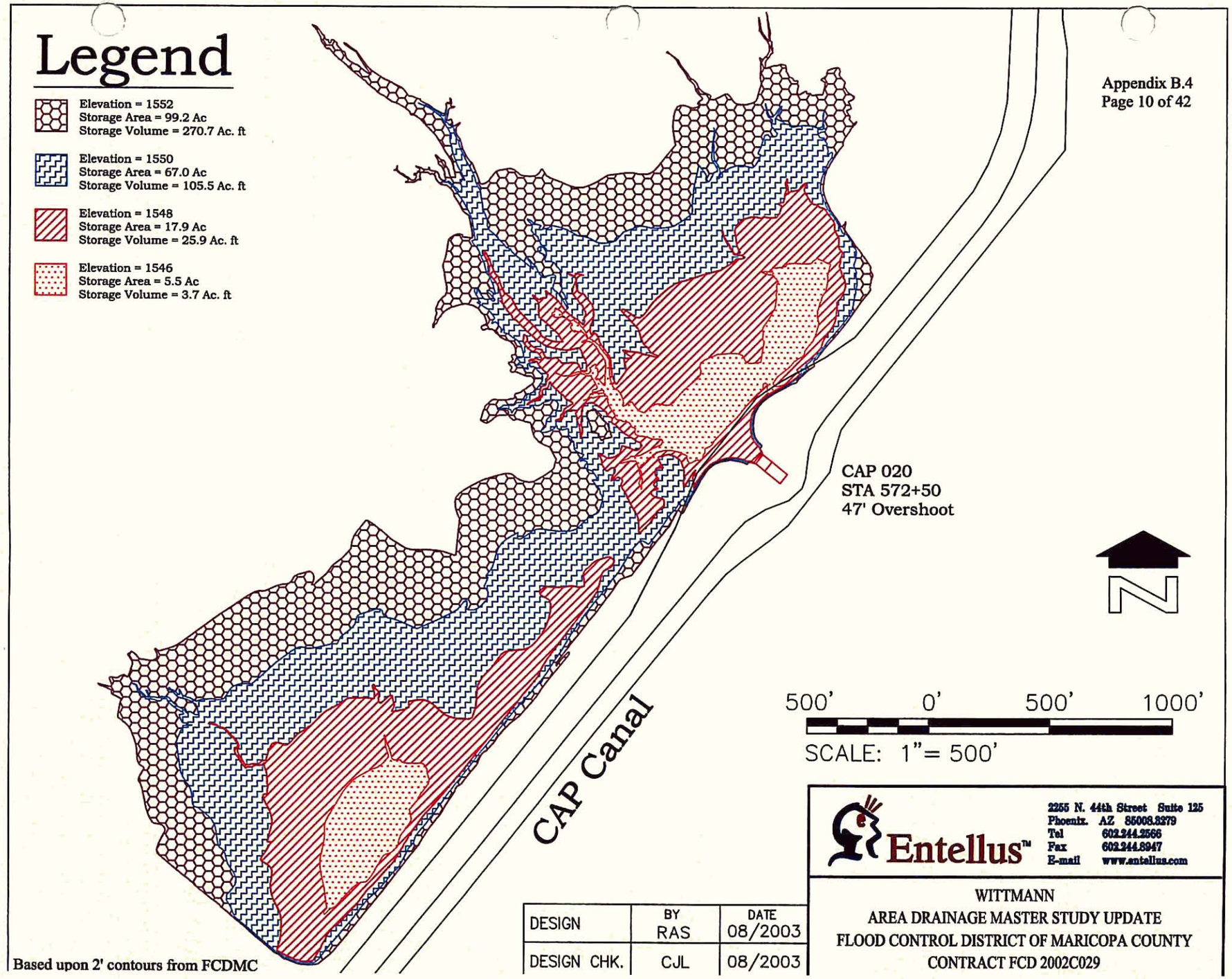
Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1546	0	5.5	0.0	0
1547.3	1.3	13.6	12.0	0
1548	0.7	17.9	23.0	94
1550	2	67.0	102.6	662
1552	2	99.2	267.5	1503
1553	1	118.3	376.0	2002
1554	1	118.3	376.0	2546

Water Surface Elevation [ft]	h [ft]	Weir coefficient (C)	Weir Length [ft]	Weir Discharge*** [cfs]
1554	1	2.7	3700	9990

*Discharge calculated energy method

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

***Weir Discharge was calculated using the equation Q_{weir}=C*L*$h^{1.5}$



Based upon 2' contours from FCDMC

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DESIGN CHK.	CJL	08/2003

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SHEET 11 OF 42

BY RAS DATE 19-Apr-04

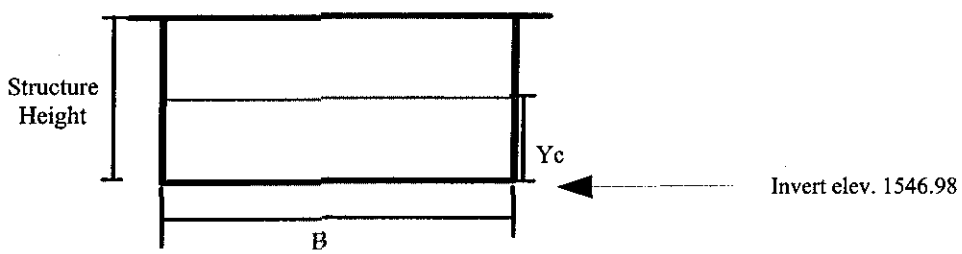
CLIENT: FCDMC CHECK JS DATE 19-Apr-04

JOB: Wittmann Area Drainage Master Study Update JOB NO. 310.032

Structure: CAP 030, Reach 8 Sta. 609+00

CRITICAL DEPTH/ ENERGY CALCULATIONS

LOCATION	CAP 030	
Bottom Width =	135	(ft)
Left side Slope =	0	:1
Rigth Side Slopes =	0	:1
Invert Elevation=	1546.98	(ft)
Berm Elevation=	1556	(ft)



Stage (ft)	Critical Depth yc (ft)	Bottom Width B (ft)	Area A (ft^2)	Velocity Head (ft)	Discharge (cfs)	Storage Area (ac)
1547.0	0.00	135.00	0.00	0.00	0.00	0.33
1548.0	0.68	135.00	91.80	0.34	429.56	0.66
1550.0	2.01	135.00	271.80	1.01	2188.44	2.13
1552.0	3.35	135.00	451.80	1.67	4690.08	5.99
1554.0	4.68	135.00	631.80	2.34	7755.87	10.04
1556.0	6.01	135.00	811.80	3.01	11296.26	16.10

Note: Elevations obtained from survey report. Storage areas estimated using topographic maps

APPENDIX D.4

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SHEET	12	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

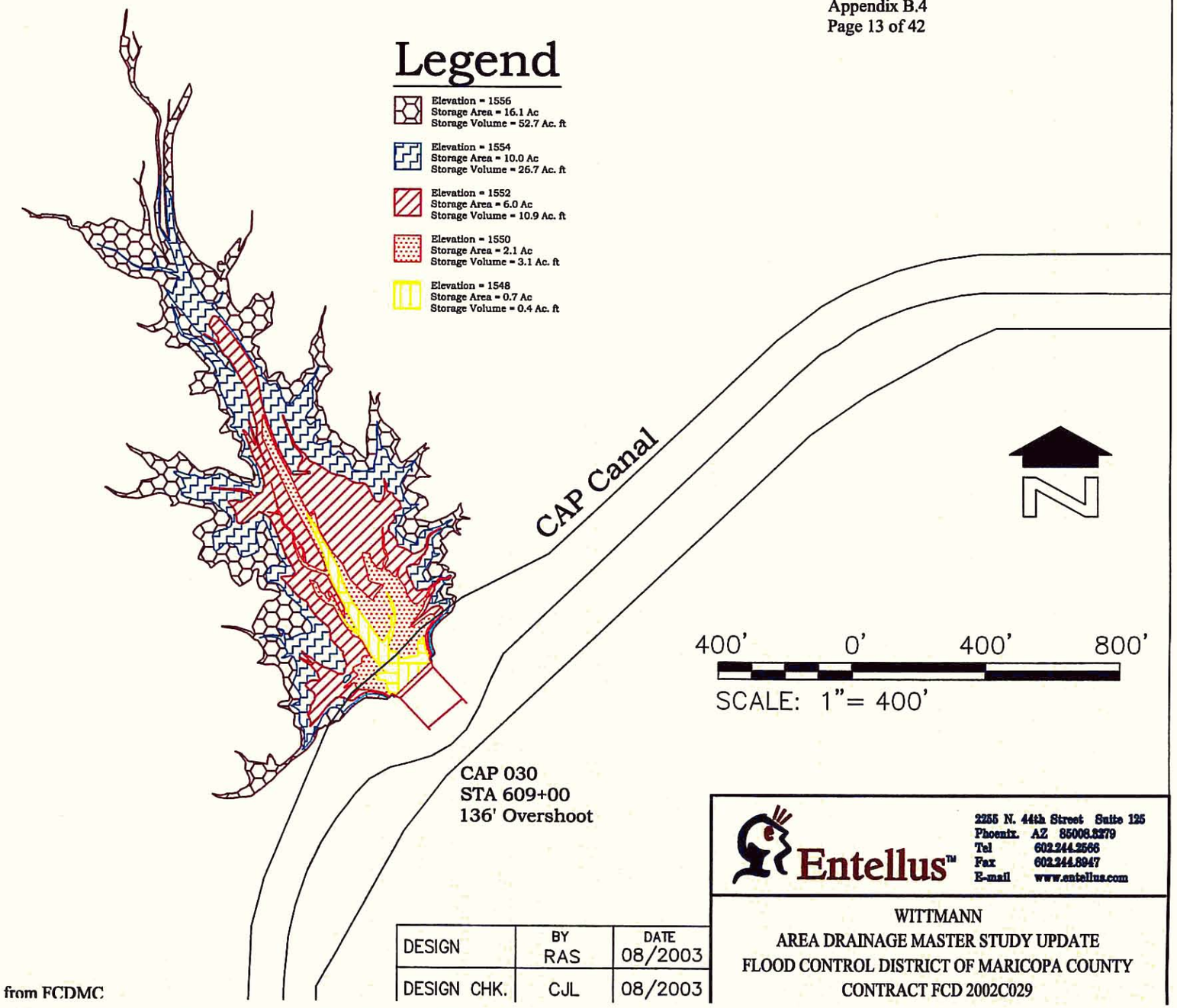
CAP Overchute Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: CAP 030

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1547	0	0.3	0.0	0
1548	1	0.7	0.5	429.56
1550	2	2.1	3.1	2188.44
1552	2	6.0	10.9	4690.08
1554	2	10.0	26.8	7755.87
1556	2	16.1	52.6	11296.26

*Discharge calculated energy method

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)



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SHEET	14	OF	42
BY	RAS	DATE	19-Apr-04
CHECK	JS	DATE	19-Apr-04
JOB NO.	310.032		

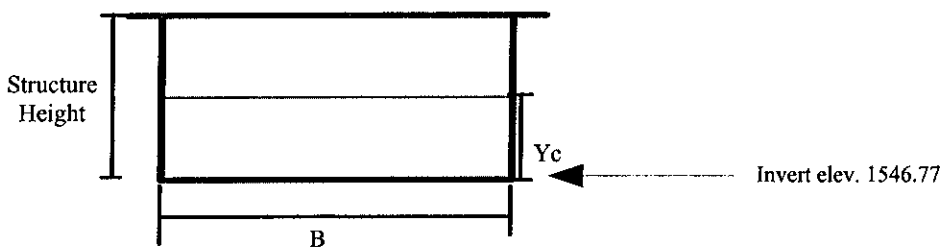
CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Structure: CAP 040, Reach 8 Sta. 688+00

CRITICAL DEPTH/ ENERGY CALCULATIONS

LOCATION	CAP 040	
Bottom Width =	87	(ft)
Left side Slope =	0	:1
Rigth Side Slopes =	0	:1
Invert Elevation=	1546.77	(ft)
Berm Elevation=	1552.7	(ft)



Stage (ft)	Critical Depth yc (ft)	Bottom Width B (ft)	Area A (ft^2)	Velocity Head (ft)	Discharge (cfs)	Storage Area (ac)
1540.0	0.00	87.00	0.00	0.00	0.00	0.48
1542.0	0.00	87.00	0.00	0.00	0.00	1.59
1544.0	0.00	87.00	0.00	0.00	0.00	3.04
1546.0	0.00	87.00	0.00	0.00	0.00	22.06
1546.8	0.00	87.00	0.00	0.00	0.00	37.08
1548.0	0.82	87.00	71.34	0.41	366.58	61.08
1550.0	2.15	87.00	187.34	1.08	1559.96	105.10
1552.0	3.49	87.00	303.34	1.74	3214.13	160.80
1552.7	3.95	87.00	343.94	1.98	3880.54	181.30
1554.0	4.82	87.00	419.34	2.41	5224.18	181.30

Note: Elevations obtained from survey report. Storage areas estimated using topographic maps

APPENDIX D.4

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SHEET	15	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Overchute Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: CAP 040

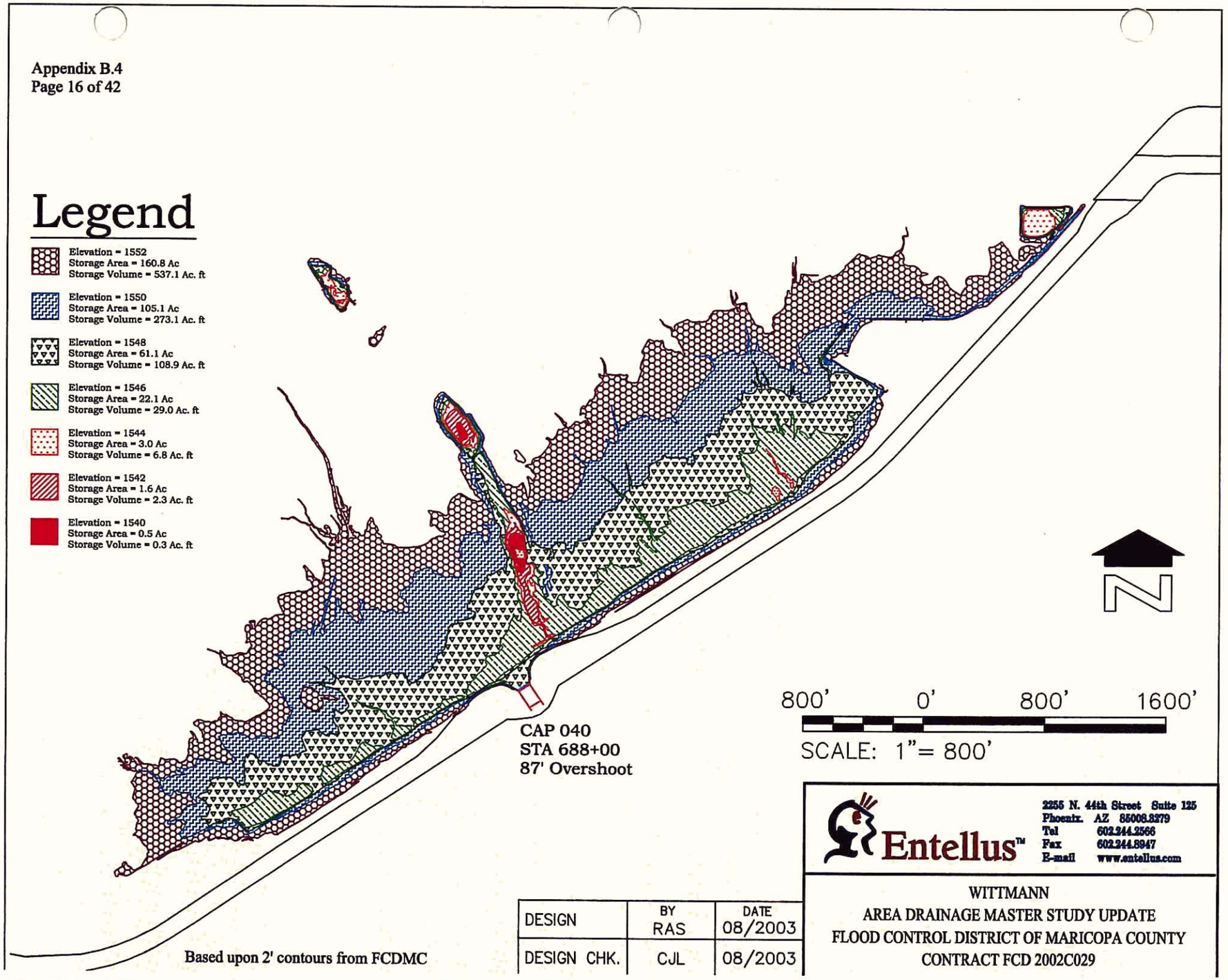
Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1540	0	0.5	0.0	0
1542	2	1.6	2.0	0
1544	2	3.0	6.5	0
1546	2	22.1	28.7	0
1546.8	0.8	37.1	52.1	0
1548	1.2	61.1	110.3	367
1550	2	105.1	274.3	1560
1552	2	160.8	538.0	3214
1552.7	0.7	181.3	657.5	3881
1554	1.3	181.3	657.5	5224

Water Surface Elevation [ft]	h [ft]	Weir coefficient (C)	Weir Length [ft]	Weir Discharge*** [cfs]
1554	1.3	2.7	5600	22411

*Discharge calculated energy method

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

***Weir Discharge was calculated using the equation Q_{weir}=C*L*$h^{1.5}$



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SHEET	17	OF	42
BY	RAS	DATE	19-Apr-04
CHECK	JS	DATE	19-Apr-04
JOB NO.	310.032		

CLIENT: FCDMC

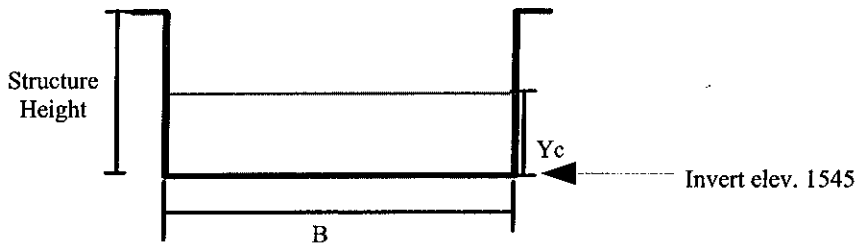
JOB: Wittmann Area Drainage Master Study Update

Structure: CAP 050, Reach 8 Sta. 804+50

CRITICAL DEPTH/ ENERGY CALCULATIONS

LOCATION CAP 050

Bottom Width =	67	(ft)
Left side Slope =	0	:1
Rigth Side Slope =	0	:1
Invert Elevation=	1545	(ft)
Berm Elevation=	1553	(ft)



Stage (ft)	Critical Depth yc (ft)	Bottom Width B (ft)	Area A (ft^2)	Velocity Head (ft)	Discharge (cfs)	Storage Area (ac)
1545.0	0.00	67.00	0.00	0.00	0.00	0.00
1546.0	0.67	67.00	44.89	0.34	208.50	0.05
1548.0	2.00	67.00	134.01	1.00	1075.52	0.74
1550.0	3.33	67.00	223.37	1.67	2314.32	11.45
1552.0	4.67	67.00	312.67	2.33	3832.77	35.26
1553.0	5.33	67.00	357.38	2.67	4683.60	54.05
1554.0	6.00	67.00	402.00	3.00	5587.66	55.05

Note: Elevations obtained from survey report. Storage areas estimated using topographic maps

APPENDIX D.4

Entellus

SHEET	18	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Overchute Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: CAP 050

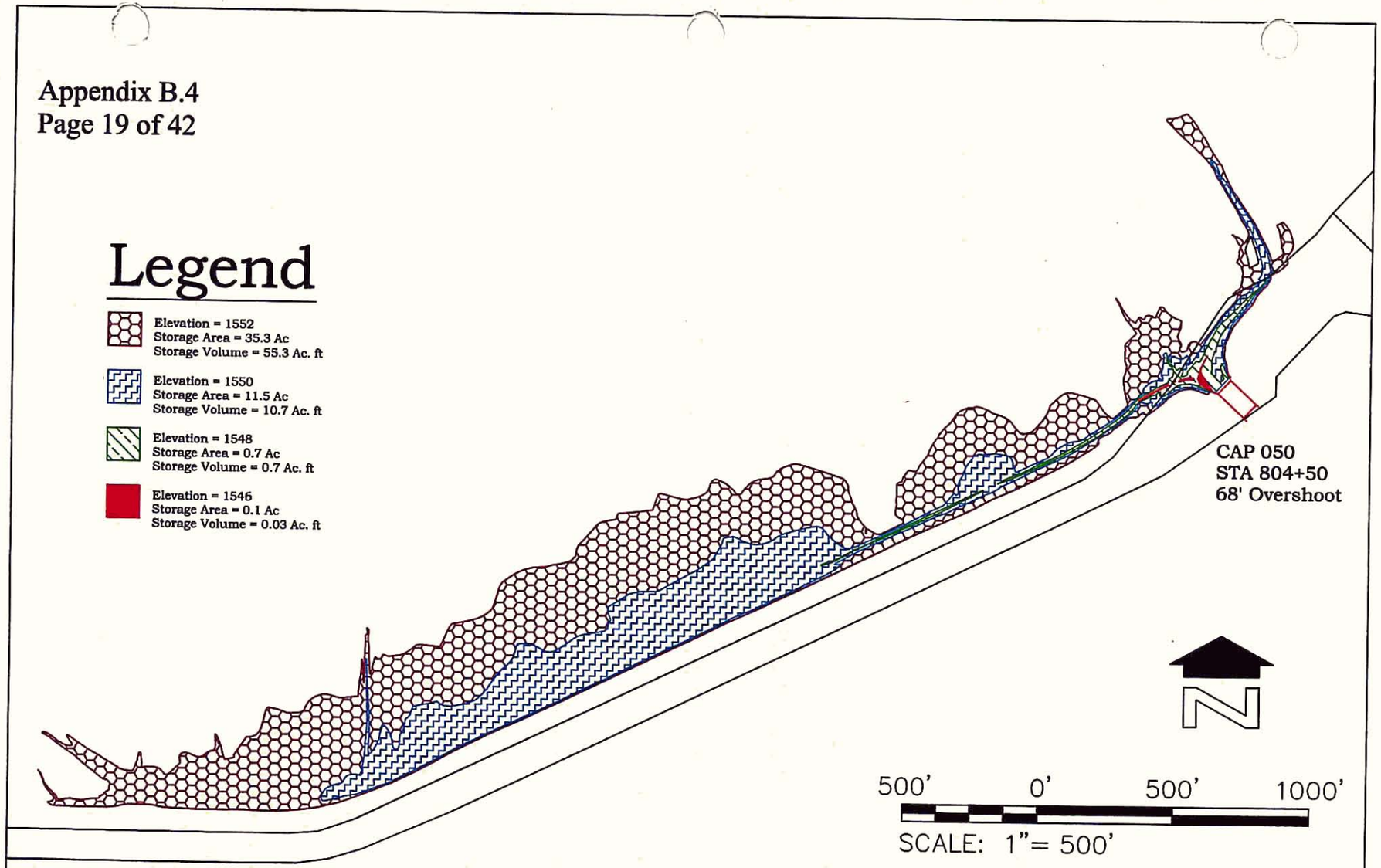
Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1545	0	0.0	0.0	0
1546	1	0.1	0.0	0
1548	2	0.7	0.7	1075.52
1550	2	11.5	10.7	2314.32
1552	2	35.3	55.2	3832.77
1553	1	54.1	99.5	4683.6
1554	1	54.1	99.5	5588

Water Surface Elevation [ft]	h [ft]	Weir coefficient (C)	Weir Length [ft]	Weir Discharge*** [cfs]
1554	1	2.7	2000	5400

*Discharge calculated energy method

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

***Weir Discharge was calculated using the equation Q_{weir}=C*L*$h^{1.5}$



Based upon 2' contours from FCDMC

	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003

Entellus™
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AREA DRAINAGE MASTER STUDY UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

APPENDIX D.4

Entellus

SHEET		OF	
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Culvert Discharge vs Water Surface Elevation/ Storage Area
Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1528	0	0.00	0.0	0
1532	4	0.00	0.0	0
1536	4	0.00	0.0	0
1540	4	0.00	0.0	0
1544	4	23.20	30.9	206
1546	2	63.00	113.8	638
1548	2	98.11	273.4	1430
1550	2	222.56	585.4	2223
1552	2	331.20	1135.0	2900
1554	2	442.50	1905.3	3395
1556	2	553.04	2897.8	3835
1557	1	553.04	2897.8	66348
1558	1	553.04	2897.8	180489

*Discharge calculated using nomograph and weir flow

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

APPENDIX D.4

Entellus

SHEET	21	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1544

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	0.71	0.12	15
CAP070	52+80	72" RCP	1543.1	72	0.9	0.15	19
CAP080	85+70	72" RCP	1542.93	72	1.07	0.18	22
CAP090	119+70	72" RCP	1542.55	72	1.45	0.24	27
CAP100	159+50	72" RCP	1542.3	72	1.7	0.28	32
CAP110	180+50	72" RCP	1542.2	72	1.8	0.30	32
CAP120	190+60	72" RCP	1542.61	72	1.39	0.23	27
CAP130	216+80	72" RCP	1542.4	72	1.6	0.27	32
CAP140	240+00	72" RCP	1544.65	72	-0.65	-0.11	0
					Q Total [CFS]:		206

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	22	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1546

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	2.71	0.45	55
CAP070	52+80	72" RCP	1543.1	72	2.9	0.48	65
CAP080	85+70	72" RCP	1542.93	72	3.07	0.51	65
CAP090	119+70	72" RCP	1542.55	72	3.45	0.58	82
CAP100	159+50	72" RCP	1542.3	72	3.7	0.62	91
CAP110	180+50	72" RCP	1542.2	72	3.8	0.63	95
CAP120	190+60	72" RCP	1542.61	72	3.39	0.57	82
CAP130	216+80	72" RCP	1542.4	72	3.6	0.60	76
CAP140	240+00	72" RCP	1544.65	72	1.35	0.22	27
					Q Total [CFS]:		638

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	23	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1548

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	4.71	0.79	143
CAP070	52+80	72" RCP	1543.1	72	4.9	0.82	150
CAP080	85+70	72" RCP	1542.93	72	5.07	0.84	157
CAP090	119+70	72" RCP	1542.55	72	5.45	0.91	172
CAP100	159+50	72" RCP	1542.3	72	5.7	0.95	185
CAP110	180+50	72" RCP	1542.2	72	5.8	0.97	200
CAP120	190+60	72" RCP	1542.61	72	5.39	0.90	172
CAP130	216+80	72" RCP	1542.4	72	5.6	0.93	185
CAP140	240+00	72" RCP	1544.65	72	3.35	0.56	66
					Q Total [CFS]:		1430

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	24	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1550

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	6.71	1.12	238
CAP070	52+80	72" RCP	1543.1	72	6.9	1.15	238
CAP080	85+70	72" RCP	1542.93	72	7.07	1.18	245
CAP090	119+70	72" RCP	1542.55	72	7.45	1.24	260
CAP100	159+50	72" RCP	1542.3	72	7.7	1.28	270
CAP110	180+50	72" RCP	1542.2	72	7.8	1.30	270
CAP120	190+60	72" RCP	1542.61	72	7.39	1.23	260
CAP130	216+80	72" RCP	1542.4	72	7.6	1.27	270
CAP140	240+00	72" RCP	1544.65	72	5.35	0.89	172
					Q Total [CFS]:		2223

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	25	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1552

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	8.71	1.45	305
CAP070	52+80	72" RCP	1543.1	72	8.9	1.48	320
CAP080	85+70	72" RCP	1542.93	72	9.07	1.51	320
CAP090	119+70	72" RCP	1542.55	72	9.45	1.58	335
CAP100	159+50	72" RCP	1542.3	72	9.7	1.62	345
CAP110	180+50	72" RCP	1542.2	72	9.8	1.63	345
CAP120	190+60	72" RCP	1542.61	72	9.39	1.57	335
CAP130	216+80	72" RCP	1542.4	72	9.6	1.60	335
CAP140	240+00	72" RCP	1544.65	72	7.35	1.22	260
					Q Total [CFS]:		2900

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entelhus

SHEET	26	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1554

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	10.71	1.79	370
CAP070	52+80	72" RCP	1543.1	72	10.9	1.82	375
CAP080	85+70	72" RCP	1542.93	72	11.07	1.84	375
CAP090	119+70	72" RCP	1542.55	72	11.45	1.91	380
CAP100	159+50	72" RCP	1542.3	72	11.7	1.95	390
CAP110	180+50	72" RCP	1542.2	72	11.8	1.97	400
CAP120	190+60	72" RCP	1542.61	72	11.39	1.90	380
CAP130	216+80	72" RCP	1542.4	72	11.6	1.93	390
CAP140	240+00	72" RCP	1544.65	72	9.35	1.56	335
					Q Total [CFS]:		3395

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Intellus

SHEET	27A	OF	42
BY	RAS	DATE	12/8/2003
CHECK	HAA	DATE	12/8/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1556

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	12.71	2.12	415
CAP070	52+80	72" RCP	1543.1	72	12.9	2.15	430
CAP080	85+70	72" RCP	1542.93	72	13.07	2.18	430
CAP090	119+70	72" RCP	1542.55	72	13.45	2.24	430
CAP100	159+50	72" RCP	1542.3	72	13.7	2.28	440
CAP110	180+50	72" RCP	1542.2	72	13.8	2.30	440
CAP120	190+60	72" RCP	1542.61	72	13.39	2.23	430
CAP130	216+80	72" RCP	1542.4	72	13.6	2.27	440
CAP140	240+00	72" RCP	1544.65	72	11.35	1.89	380
					Q Total [CFS]:		3835

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	27B	OF	42
BY	AMG	DATE	1/28/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1557

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	13.71	2.29	440
CAP070	52+80	72" RCP	1543.1	72	13.9	2.32	440
CAP080	85+70	72" RCP	1542.93	72	14.07	2.34	440
CAP090	119+70	72" RCP	1542.55	72	14.45	2.41	455
CAP100	159+50	72" RCP	1542.3	72	14.7	2.45	465
CAP110	180+50	72" RCP	1542.2	72	14.8	2.47	465
CAP120	190+60	72" RCP	1542.61	72	14.39	2.40	455
CAP130	216+80	72" RCP	1542.4	72	14.6	2.43	455
CAP140	240+00	72" RCP	1544.65	72	12.35	2.06	415

Weir Flow Over CAP Embankment

Diversion/ Route	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
RWI542	2.7	1556	1	2035	5494
DCAPOT	2.7	1556	1	2369	6397
DCAP07	2.7	1556	1	2199	5938
DCAP08	2.7	1556	1	411	1110
DCAP09	2.7	1556	1	4909	13253
DCAP10	2.7	1556	1	3509	9474
DCAP11	2.7	1556	1	1105	2983
DCAP12	2.7	1556	1	1208	3261
DCAP13	2.7	1556	1	2553	6893
DCAP14	2.7	1556	1	2783	7515
				Q Total [CFS]:	66348

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

APPENDIX D.4

Entellus

SHEET		OF	
BY	AMG	DATE	1/28/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP60-140

Water Surface Elevation: 1558

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP060	36+12	72" RCP	1543.29	72	14.71	2.45	465
CAP070	52+80	72" RCP	1543.1	72	14.9	2.48	465
CAP080	85+70	72" RCP	1542.93	72	15.07	2.51	465
CAP090	119+70	72" RCP	1542.55	72	15.45	2.58	480
CAP100	159+50	72" RCP	1542.3	72	15.7	2.62	480
CAP110	180+50	72" RCP	1542.2	72	15.8	2.63	480
CAP120	190+60	72" RCP	1542.61	72	15.39	2.57	480
CAP130	216+80	72" RCP	1542.4	72	15.6	2.60	480
CAP140	240+00	72" RCP	1544.65	72	13.35	2.22	430

Weir Flow Over CAP Embankment

Diversion/ Route	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
RWI542	2.7	1556	2	2035	15540
DCAPOT	2.7	1556	2	2369	18093
DCAP07	2.7	1556	2	2199	16796
DCAP08	2.7	1556	2	411	3139
DCAP09	2.7	1556	2	4909	37487
DCAP10	2.7	1556	2	3509	26797
DCAP11	2.7	1556	2	1105	8438
DCAP12	2.7	1556	2	1208	9223
DCAP13	2.7	1556	2	2553	19495
DCAP14	2.7	1556	2	2783	21256
				Q Total [CFS]:	180489

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

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SHEET 28 OF 42
BY RAS DATE 8-25-03
CHECK CJL DATE 9-8-03

CLIENT FCDMC
JOB NAME Wittmann Area Drainage Master Study Update JOB NO. 316.032

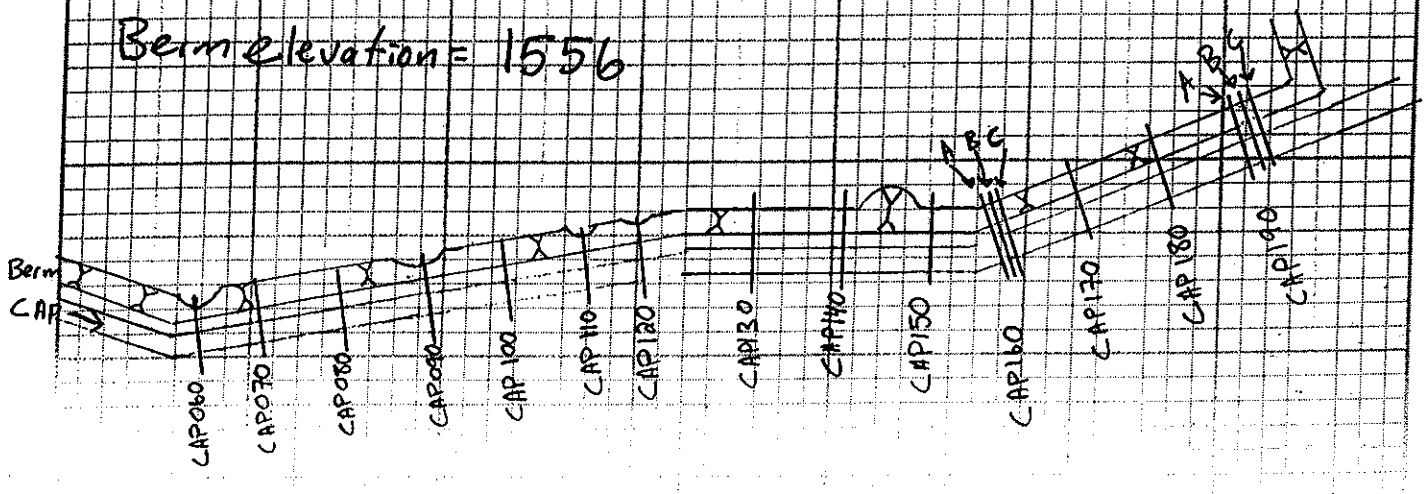
CAP IMPOUNDMENT CAP060 thru 190

All 72" pipe overchutes

Structures:

	Sta.
CAP060	36+12
CAP070	52+80
CAP080	85+70
CAP090	119+70
CAP100	159+50
CAP110	180+50
CAP120	190+60
CAP130	216+80
CAP140	240+00
CAP150	253+00
CAP160	272+35 (3 barrels)
CAP170	279+00
CAP180	298+70
CAP190	315+00 (3 barrels)

Berm elevation = 1556



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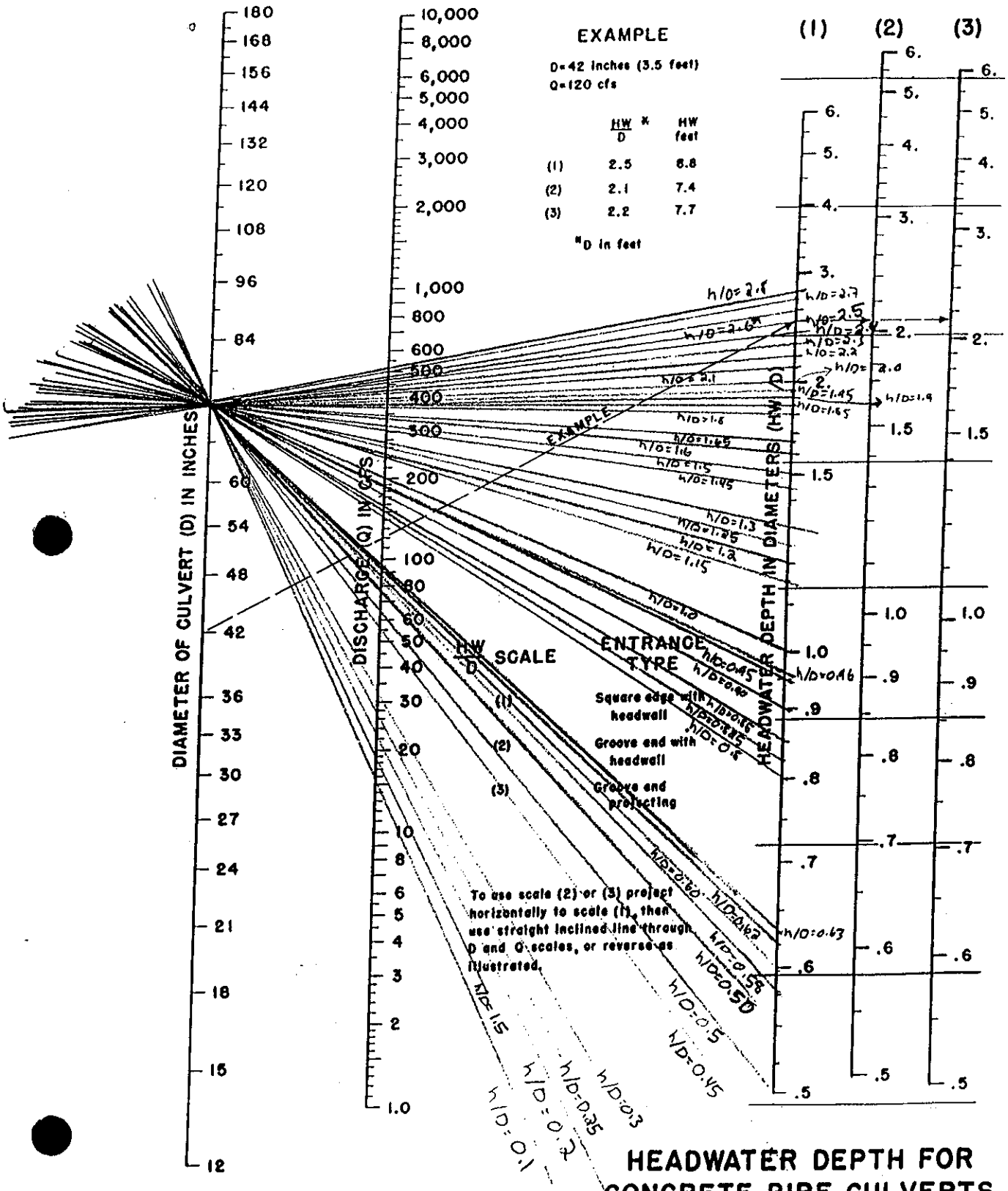
SHEET 29 OF 42
BY RAS DATE 8-25-03
CHECK CJL DATE 9-8-03

CLIENT FCDMC-Wittmann Area Drainage Master Study Update

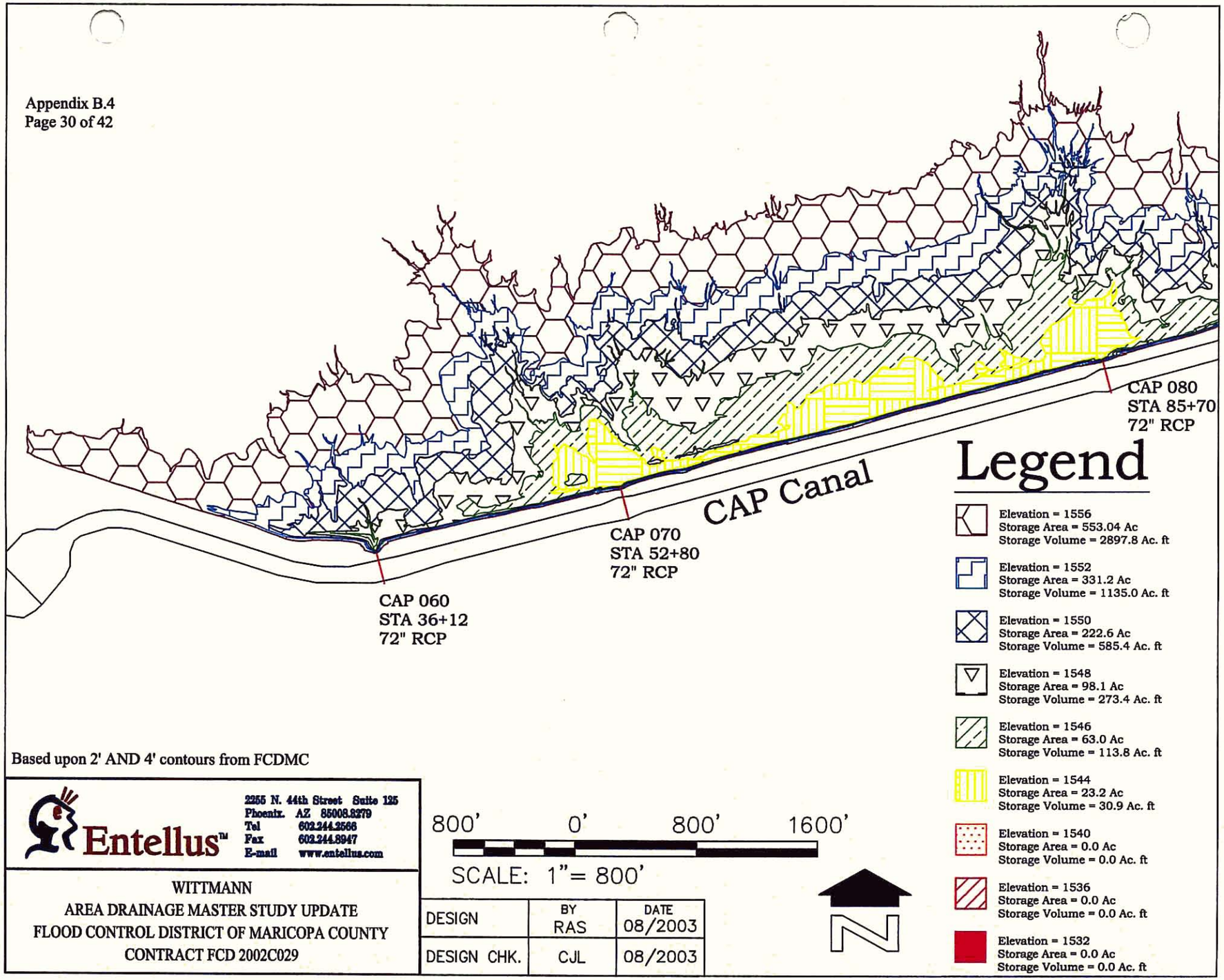
CHART 1



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1965



Based upon 2' AND 4' contours from FCDMC

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Phoenix, AZ 85008-8279
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E-mail www.entellus.com

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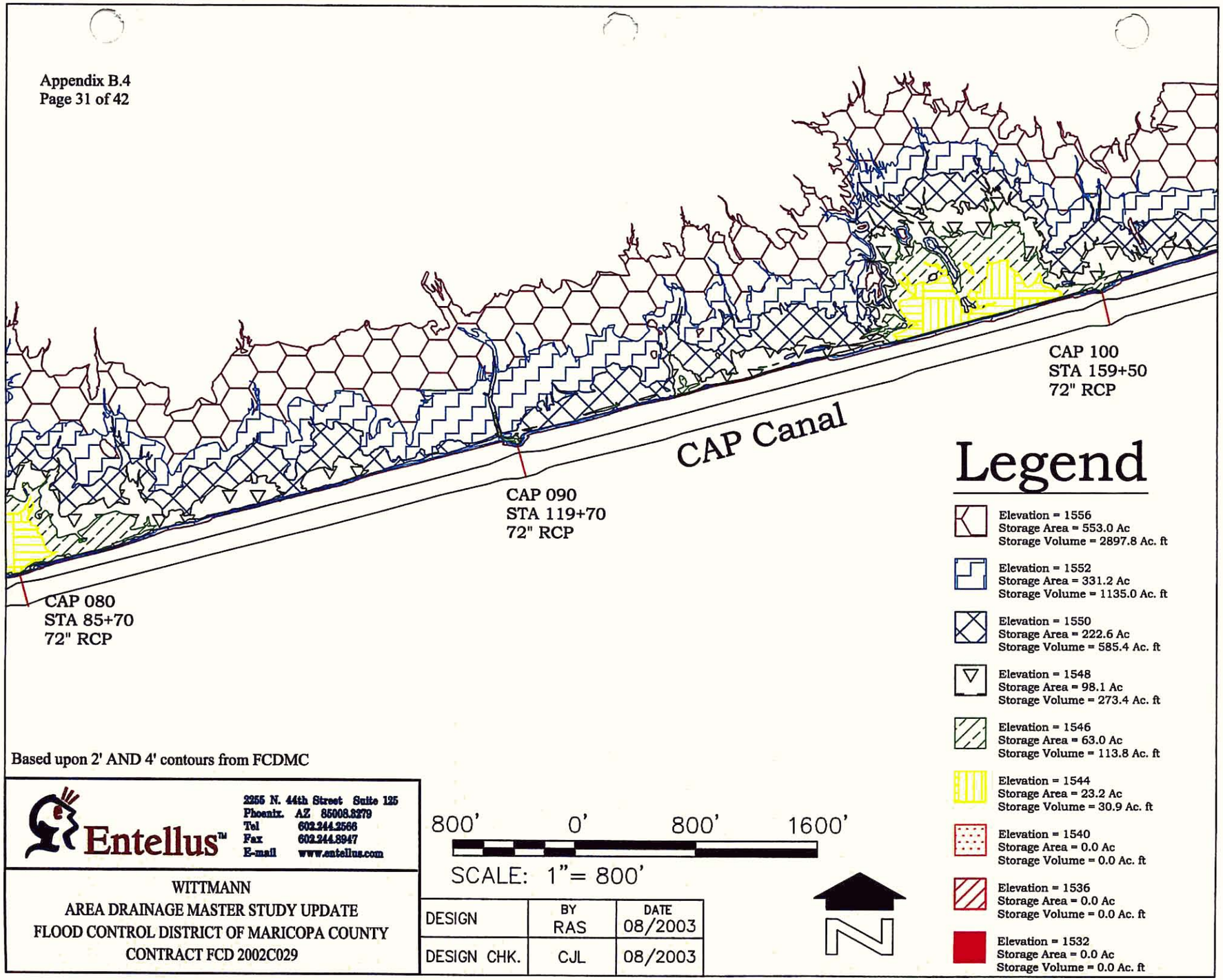
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003



Based upon 2' AND 4' contours from FCDMC

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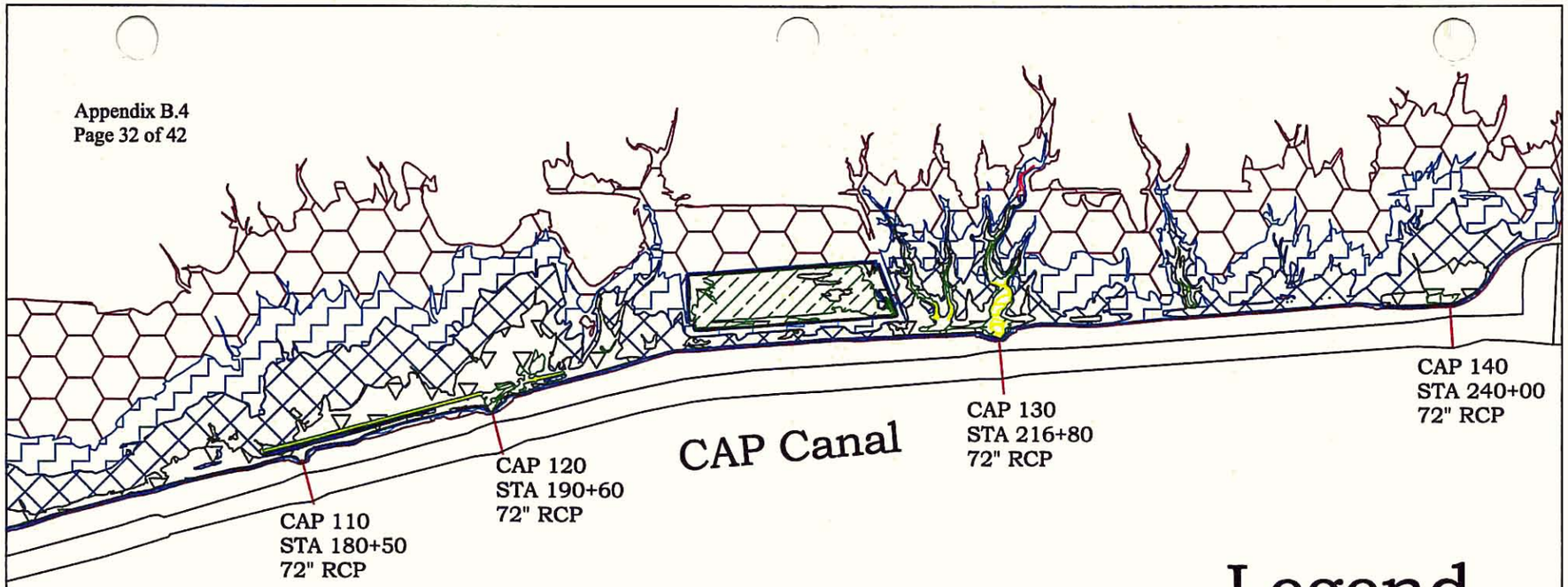
WITTMANN
AREA DRAINAGE MASTER STUDY UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003



Legend

- Elevation = 1556
  Storage Area = 553.0 Ac
  Storage Volume = 2897.8 Ac. ft
- Elevation = 1552
  Storage Area = 331.2 Ac
  Storage Volume = 1135.0 Ac. ft
- Elevation = 1550
  Storage Area = 222.6 Ac
  Storage Volume = 585.4 Ac. ft
- Elevation = 1548
  Storage Area = 98.1 Ac
  Storage Volume = 273.4 Ac. ft
- Elevation = 1546
  Storage Area = 63.0 Ac
  Storage Volume = 113.8 Ac. ft
- Elevation = 1544
  Storage Area = 23.2 Ac
  Storage Volume = 30.9 Ac. ft
- Elevation = 1540
  Storage Area = 0.0 Ac
  Storage Volume = 0.0 Ac. ft
- Elevation = 1536
  Storage Area = 0.0 Ac
  Storage Volume = 0.0 Ac. ft
- Elevation = 1532
  Storage Area = 0.0 Ac
  Storage Volume = 0.0 Ac. ft

Based upon 2' AND 4' contours from FCDMC

Entellus™
2255 N. 44th Street Suite 125
Phoenix, AZ 85008-3279
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WITTMANN
AREA DRAINAGE MASTER STUDY UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

800' 0' 800' 1600'
SCALE: 1"= 800'

	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003

APPENDIX D.4

Entellus

SHEET		OF	
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Culvert Discharge vs Water Surface Elevation/ Storage Area
Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1528	0	0.0	0.0	0
1532	4	0.2	0.3	0
1536	4	0.8	2.2	0
1540	4	4.4	11.6	0
1544	4	37.3	84.4	492
1546	2	67.7	187.8	1221
1548	2	97.0	351.4	2032
1550	2	126.2	573.8	2700
1552	2	154.8	854.0	3330
1554	2	182.8	1190.9	3820
1556	2	210.8	1583.8	4150
1557	1	210.8	1583.8	25076
1558	1	210.8	1583.8	63233

*Discharge calculated using nomograph and weir flow

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

APPENDIX D.4

Entellus

SHEET	21	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1544

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	1.15	0.19	22
CAP160	272+35	3 - 72" RCP	1541.32	72	2.68	0.45	165
CAP170	279+00	72" RCP	1541.37	72	2.63	0.44	55
CAP180	298+70	72" RCP	1541.23	72	2.77	0.46	55
CAP190	315+00	3 - 72" RCP	1541.02	72	2.98	0.50	195
					Q Total [CFS]:		492

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	22	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1546

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	3.15	0.53	66
CAP160	272+35	3 - 72" RCP	1541.32	72	4.68	0.78	420
CAP170	279+00	72" RCP	1541.37	72	4.63	0.77	140
CAP180	298+70	72" RCP	1541.23	72	4.77	0.79	145
CAP190	315+00	3 - 72" RCP	1541.02	72	4.98	0.83	450
					Q Total [CFS]:		1221

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	23	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1548

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	5.15	0.86	157
CAP160	272+35	3 - 72" RCP	1541.32	72	6.68	1.11	690
CAP170	279+00	72" RCP	1541.37	72	6.63	1.11	230
CAP180	298+70	72" RCP	1541.23	72	6.77	1.13	235
CAP190	315+00	3 - 72" RCP	1541.02	72	6.98	1.16	720
					Q Total [CFS]:		2032

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	24	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1550

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	7.15	1.19	245
CAP160	272+35	3 - 72" RCP	1541.32	72	8.68	1.45	900
CAP170	279+00	72" RCP	1541.37	72	8.63	1.44	300
CAP180	298+70	72" RCP	1541.23	72	8.77	1.46	310
CAP190	315+00	3 - 72" RCP	1541.02	72	8.98	1.50	945
					Q Total [CFS]:		2700

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	25	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1552

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	9.15	1.53	320
CAP160	272+35	3 - 72" RCP	1541.32	72	10.68	1.78	1125
CAP170	279+00	72" RCP	1541.37	72	10.63	1.77	370
CAP180	298+70	72" RCP	1541.23	72	10.77	1.80	375
CAP190	315+00	3 - 72" RCP	1541.02	72	10.98	1.83	1140
					Q Total [CFS]:		3330

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	26	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1554

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	11.15	1.86	380
CAP160	272+35	3 - 72" RCP	1541.32	72	12.68	2.11	1290
CAP170	279+00	72" RCP	1541.37	72	12.63	2.11	430
CAP180	298+70	72" RCP	1541.23	72	12.77	2.13	430
CAP190	315+00	3 - 72" RCP	1541.02	72	12.98	2.16	1290
					Q Total [CFS]:		3820

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	27A	OF	42
BY	RAS	DATE	12/8/2003
CHECK	HAA	DATE	12/8/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1556

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	13.15	2.19	430
CAP160	272+35	3 - 72" RCP	1541.32	72	14.68	2.45	1395
CAP170	279+00	72" RCP	1541.37	72	14.63	2.44	465
CAP180	298+70	72" RCP	1541.23	72	14.77	2.46	465
CAP190	315+00	3 - 72" RCP	1541.02	72	14.98	2.50	1395
						Q Total [CFS]:	**4150**

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	27B	OF	42
BY	AMG	DATE	1/28/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1557

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	14.15	2.36	455
CAP160	272+35	3 - 72" RCP	1541.32	72	15.68	2.61	1440
CAP170	279+00	72" RCP	1541.37	72	15.63	2.61	480
CAP180	298+70	72" RCP	1541.23	72	15.77	2.63	480
CAP190	315+00	3 - 72" RCP	1541.02	72	15.98	2.66	1500

Weir Flow Over CAP Embankment

Diversion/ Route	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
DCAP15	2.7	1556	1	1127	3044
DCAP16	2.7	1556	1	1948	5259
DCAP17	2.7	1556	1	2059	5559
DCAP18	2.7	1556	1	899	2428
DCAP19	2.7	1556	1	1641	4431
				Q Total [CFS]:	25076

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

APPENDIX D.4

Entellus

SHEET	27C	OF	42
BY	AMG	DATE	1/28/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1558

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	15.15	2.53	465
CAP160	272+35	3 - 72" RCP	1541.32	72	16.68	2.78	1560
CAP170	279+00	72" RCP	1541.37	72	16.63	2.77	520
CAP180	298+70	72" RCP	1541.23	72	16.77	2.80	520
CAP190	315+00	3 - 72" RCP	1541.02	72	16.98	2.83	1560

Weir Flow Over CAP Embankment

Diversion/ Route	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
DCAP15	2.7	1556	2	1127	8610
DCAP16	2.7	1556	2	1948	14876
DCAP17	2.7	1556	2	2059	15724
DCAP18	2.7	1556	2	899	6866
DCAP19	2.7	1556	2	1641	12532
				Q Total [CFS]:	63233

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

APPENDIX D.4

Entellus

SHEET		OF	
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Culvert Discharge vs Water Surface Elevation/ Storage Area
Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	Discharge* [cfs]
1528	0	0.0	0.0	0
1532	4	0.2	0.3	0
1536	4	0.8	2.2	0
1540	4	4.4	11.6	0
1544	4	37.3	84.4	492
1546	2	67.7	187.8	1221
1548	2	97.0	351.4	2032
1550	2	126.2	573.8	2700
1552	2	154.8	854.0	3330
1554	2	182.8	1190.9	3820
1556	2	210.8	1583.8	4150
1557	1	210.8	1583.8	25076
1558	1	210.8	1583.8	63233

*Discharge calculated using nomograph and weir flow

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

APPENDIX D.4

Entellus

SHEET	21	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1544

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	1.15	0.19	22
CAP160	272+35	3 - 72" RCP	1541.32	72	2.68	0.45	165
CAP170	279+00	72" RCP	1541.37	72	2.63	0.44	55
CAP180	298+70	72" RCP	1541.23	72	2.77	0.46	55
CAP190	315+00	3 - 72" RCP	1541.02	72	2.98	0.50	195
					Q Total [CFS]:		492

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	22	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1546

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	3.15	0.53	66
CAP160	272+35	3 - 72" RCP	1541.32	72	4.68	0.78	420
CAP170	279+00	72" RCP	1541.37	72	4.63	0.77	140
CAP180	298+70	72" RCP	1541.23	72	4.77	0.79	145
CAP190	315+00	3 - 72" RCP	1541.02	72	4.98	0.83	450
					Q Total [CFS]:		1221

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	23	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1548

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	5.15	0.86	157
CAP160	272+35	3 - 72" RCP	1541.32	72	6.68	1.11	690
CAP170	279+00	72" RCP	1541.37	72	6.63	1.11	230
CAP180	298+70	72" RCP	1541.23	72	6.77	1.13	235
CAP190	315+00	3 - 72" RCP	1541.02	72	6.98	1.16	720
					Q Total [CFS]:		2032

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	24	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1550

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	7.15	1.19	245
CAP160	272+35	3 - 72" RCP	1541.32	72	8.68	1.45	900
CAP170	279+00	72" RCP	1541.37	72	8.63	1.44	300
CAP180	298+70	72" RCP	1541.23	72	8.77	1.46	310
CAP190	315+00	3 - 72" RCP	1541.02	72	8.98	1.50	945
					Q Total [CFS]:		2700

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Intellus

SHEET	25	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1552

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	9.15	1.53	320
CAP160	272+35	3 - 72" RCP	1541.32	72	10.68	1.78	1125
CAP170	279+00	72" RCP	1541.37	72	10.63	1.77	370
CAP180	298+70	72" RCP	1541.23	72	10.77	1.80	375
CAP190	315+00	3 - 72" RCP	1541.02	72	10.98	1.83	1140
					Q Total [CFS]:		3330

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	26	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1554

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	11.15	1.86	380
CAP160	272+35	3 - 72" RCP	1541.32	72	12.68	2.11	1290
CAP170	279+00	72" RCP	1541.37	72	12.63	2.11	430
CAP180	298+70	72" RCP	1541.23	72	12.77	2.13	430
CAP190	315+00	3 - 72" RCP	1541.02	72	12.98	2.16	1290
					Q Total [CFS]:		3820

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	27A	OF	42
BY	RAS	DATE	12/8/2003
CHECK	HAA	DATE	12/8/2003
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1556

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	13.15	2.19	430
CAP160	272+35	3 - 72" RCP	1541.32	72	14.68	2.45	1395
CAP170	279+00	72" RCP	1541.37	72	14.63	2.44	465
CAP180	298+70	72" RCP	1541.23	72	14.77	2.46	465
CAP190	315+00	3 - 72" RCP	1541.02	72	14.98	2.50	1395
					Q Total [CFS]:		4150

* Flows were calculated using nomograph for inlet control culverts

APPENDIX D.4

Entellus

SHEET	27B	OF	42
BY	AMG	DATE	1/28/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1557

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	14.15	2.36	455
CAP160	272+35	3 - 72" RCP	1541.32	72	15.68	2.61	1440
CAP170	279+00	72" RCP	1541.37	72	15.63	2.61	480
CAP180	298+70	72" RCP	1541.23	72	15.77	2.63	480
CAP190	315+00	3 - 72" RCP	1541.02	72	15.98	2.66	1500

Weir Flow Over CAP Embankment

Diversion/ Route	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
DCAP15	2.7	1556	1	1127	3044
DCAP16	2.7	1556	1	1948	5259
DCAP17	2.7	1556	1	2059	5559
DCAP18	2.7	1556	1	899	2428
DCAP19	2.7	1556	1	1641	4431
				Q Total [CFS]:	**25076**

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

APPENDIX D.4

Entellus

SHEET	27C	OF	42
BY	AMG	DATE	1/28/2004
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Discharge Calculations for Culvert System

Location/ Description: Impoundment Area East of US60 CAP150-190

Water Surface Elevation: 1558

Culvert ID	Station	Description	Invert Elevation [feet]	D [inches]	HW [ft]	HW/D [ft/ft]	Q* [cfs]
CAP150	253+00	72" RCP	1542.85	72	15.15	2.53	465
CAP160	272+35	3 - 72" RCP	1541.32	72	16.68	2.78	1560
CAP170	279+00	72" RCP	1541.37	72	16.63	2.77	520
CAP180	298+70	72" RCP	1541.23	72	16.77	2.80	520
CAP190	315+00	3 - 72" RCP	1541.02	72	16.98	2.83	1560

Weir Flow Over CAP Embankment

Diversion/ Route	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
DCAP15	2.7	1556	2	1127	8610
DCAP16	2.7	1556	2	1948	14876
DCAP17	2.7	1556	2	2059	15724
DCAP18	2.7	1556	2	899	6866
DCAP19	2.7	1556	2	1641	12532
				Q Total [CFS]:	63233

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

Entellus™

SHEET 28 OF 42
BY RAS DATE 8-25-03
CHECK CJL DATE 9-8-03

CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study Update JOB NO. 316.032

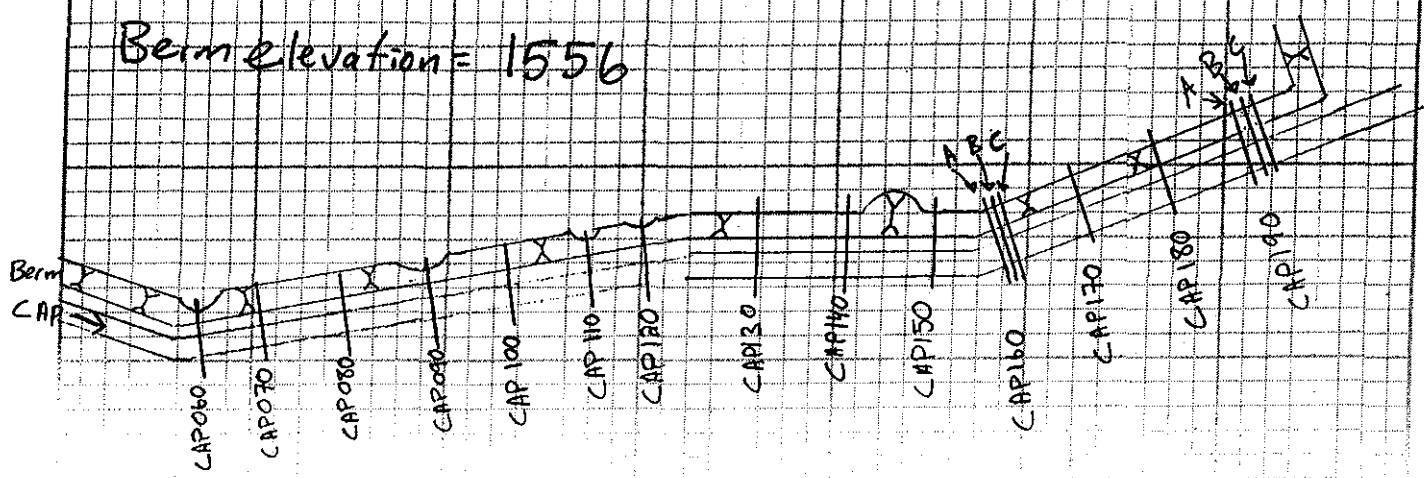
CAP IMPOUNDMENT CAP060 thru 190

All 72" pipe overchutes

Structures:

	Sta.
CAP060	36+12
CAP070	52+80
CAP080	85+70
CAP090	119+70
CAP100	159+50
CAP110	180+50
CAP120	190+60
CAP130	216+80
CAP140	240+00
CAP150	253+00
CAP160	272+35 (3 barrels)
CAP170	279+00
CAP180	298+70
CAP190	315+00 (3 barrels)

Berm elevation = 1556

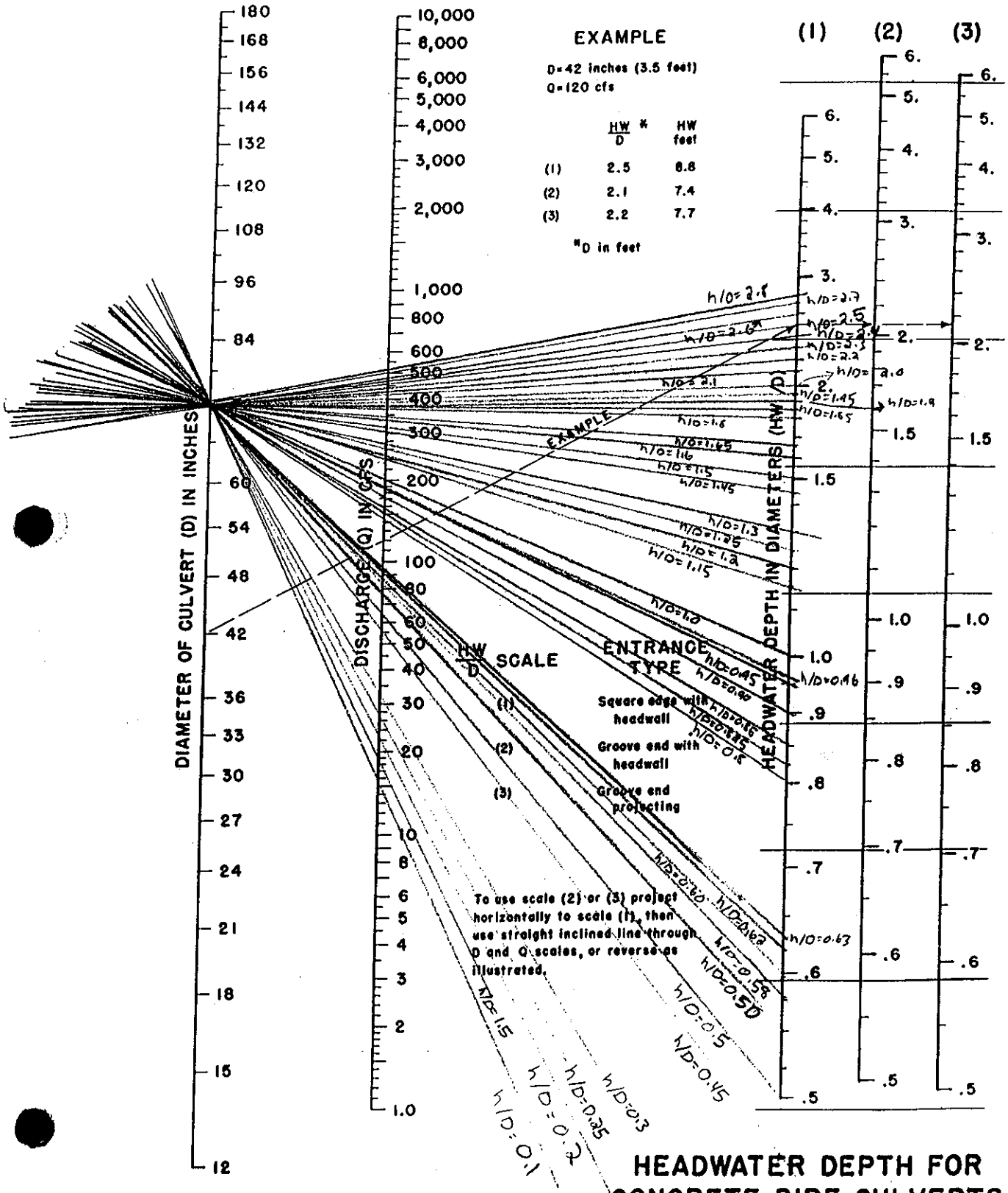


Entellus™

SHEET 29 OF 42
BY RAS DATE 8-25-03
CHECK CJL DATE 9-8-03

CLIENT FCDMC-Wittmann Area Drainage Master Study Update

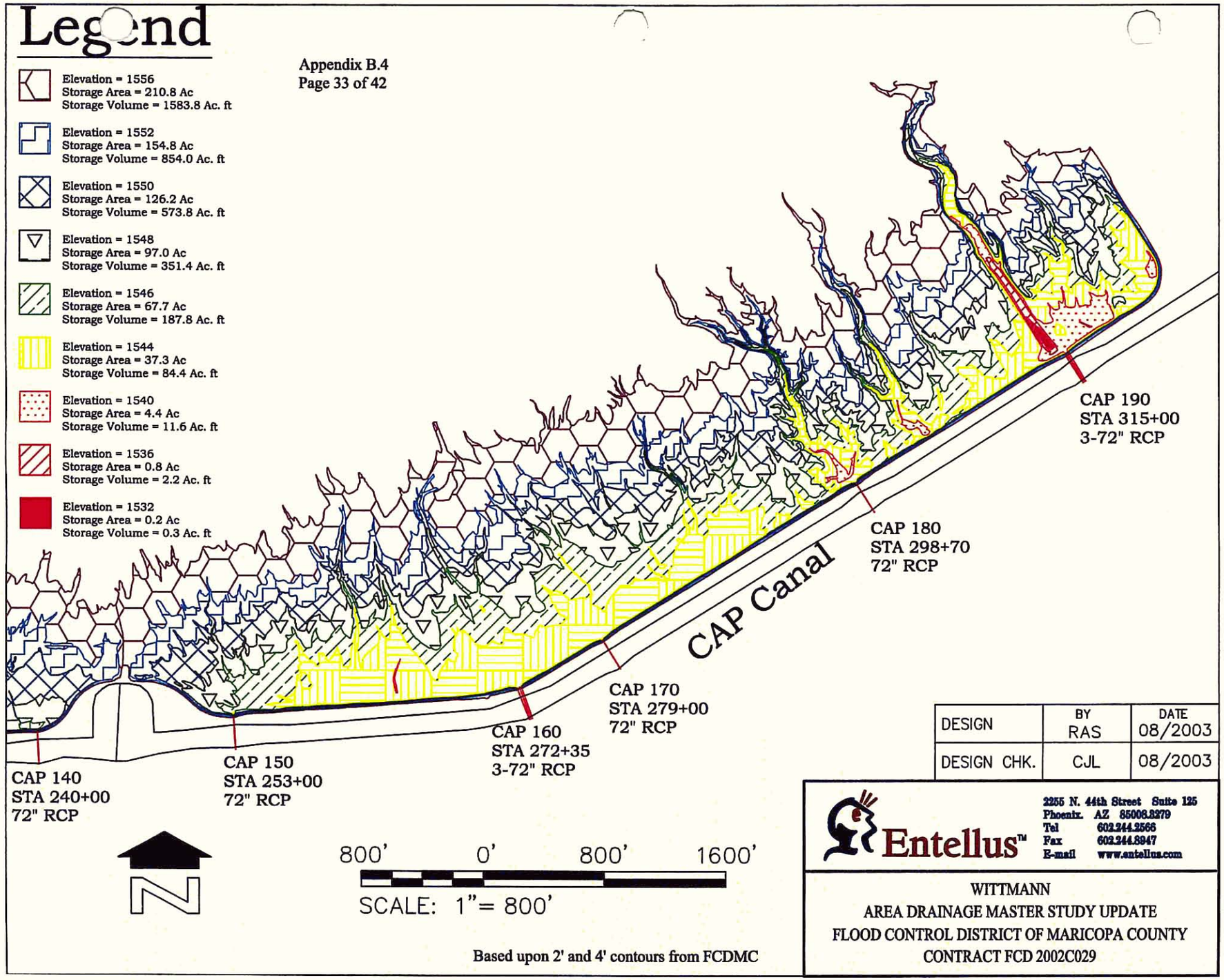
CHART 1



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL



Based upon 2' and 4' contours from FCDMC

DESIGN	BY RAS	DATE 08/2003
DESIGN CHK.	CJL	08/2003

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WITTMANN
AREA DRAINAGE MASTER STUDY UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

APPENDIX D.4

Entellus

SHEET	34	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Culvert Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: Impoundment Area East of US60 CAP200 Sta. 342+40 72" RCP

Diameter [inches] 72
Invert Elevation [feet] 1518.5
Berm Elevation [feet] 1541.4

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	H/D [ft/ft]	Discharge* [cfs]
1520	0	0.0	0.0	0.3	25
1524	4	1.3	2.0	0.9	175
1528	4	6.0	15.3	1.6	335
1532	4	18.0	61.1	2.3	440
1536	4	40.0	174.2	2.9	530
1540	4	69.9	391.0	3.6	600
1541.4	1.4	80.6	496.1	3.8	620
1542.4	1	80.6	496.1	4.0	650
1543.4	1	80.6	496.1	4.2	670

Water Surface Elevation [ft]	h [ft]	Weir coefficient (C)	Weir Length [ft]	Weir Discharge*** [cfs]
1542.4	1	2.7	3800	10260
1543.4	2	2.7	3800	29020

*Discharge calculated using nomograph

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

***Weir Discharge was calculated using the equation Q_{weir}=C*L*$h^{1.5}$

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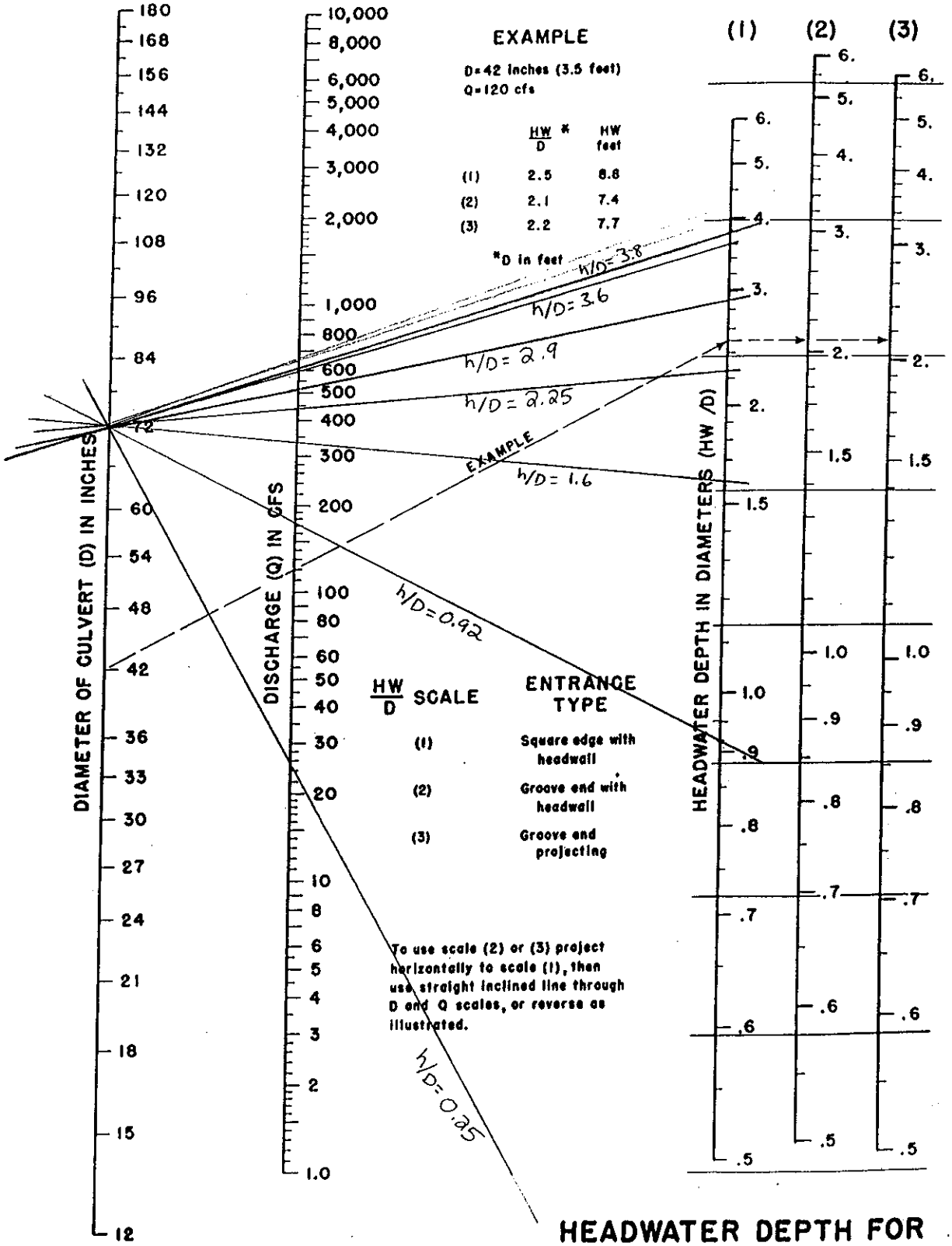
SHEET 35 OF 42
BY RAS DATE 8-20-03
CHECK CJL DATE 9-8-03

CLIENT ECDMC: Wittmann Area Drainage Master Study Update
CAP200

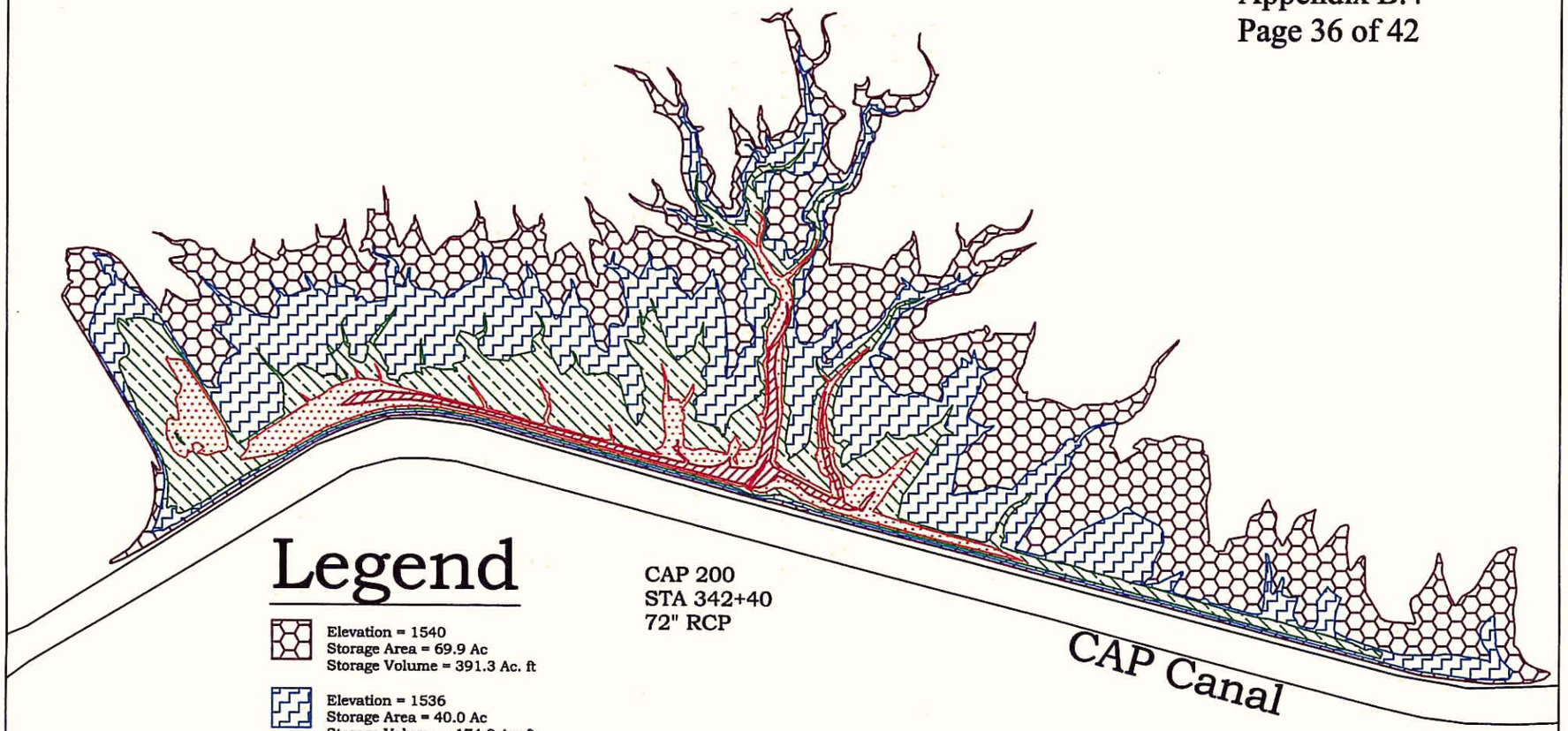
CHART 1



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963



Legend

CAP 200
STA 342+40
72" RCP

- Elevation = 1540
  Storage Area = 69.9 Ac
  Storage Volume = 391.3 Ac. ft
- Elevation = 1536
  Storage Area = 40.0 Ac
  Storage Volume = 174.2 Ac. ft
- Elevation = 1532
  Storage Area = 18.0 Ac
  Storage Volume = 61.0 Ac. ft
- Elevation = 1528
  Storage Area = 5.9 Ac
  Storage Volume = 15.3 Ac. ft
- Elevation = 1524
  Storage Area = 1.3 Ac
  Storage Volume = 2.0 Ac. ft
- Elevation = 1520
  Storage Area = 0.02 Ac
  Storage Volume = 0.03 Ac. ft

500' 0' 500' 1000'

SCALE: 1"= 500'

N

Based upon 4' contours from FCDMC and 2' ASCII grid files

	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

APPENDIX D.4

Entellus

SHEET	37	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Culvert Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: Impoundment Area East of US60 CAP210 Sta. 376+80 4 x 84" RCP

Diameter [inches] 84
Invert Elevation [feet] 1512.7
Berm Elevation [feet] 1541.8

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	H/D [ft/ft]	Discharge* [cfs]
1516	0	0.3	0.0	0.5	372
1520	4	0.8	2.0	1.0	1240
1524	4	1.4	6.3	1.6	1900
1528	4	2.7	14.3	2.2	2480
1532	4	6.5	32.1	2.8	2880
1536	4	13.8	71.7	3.3	3280
1540	4	22.4	143.4	3.9	3600
1541.8	1.8	27.0	187.8	4.2	3760
1542.8	1	27.0	187.8	4.3	3800
1543.8	1	27.0	187.8	4.4	3840

Water Surface Elevation [ft]	h [ft]	Weir coefficient (C)	Weir Length [ft]	Weir Discharge*** [cfs]
1542.8	1	2.7	2200	5940
1543.8	2	2.7	2200	16801

*Discharge calculated using nomograph

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

***Weir Discharge was calculated using the equation Q_{weir}=C*L*$h^{1.5}$

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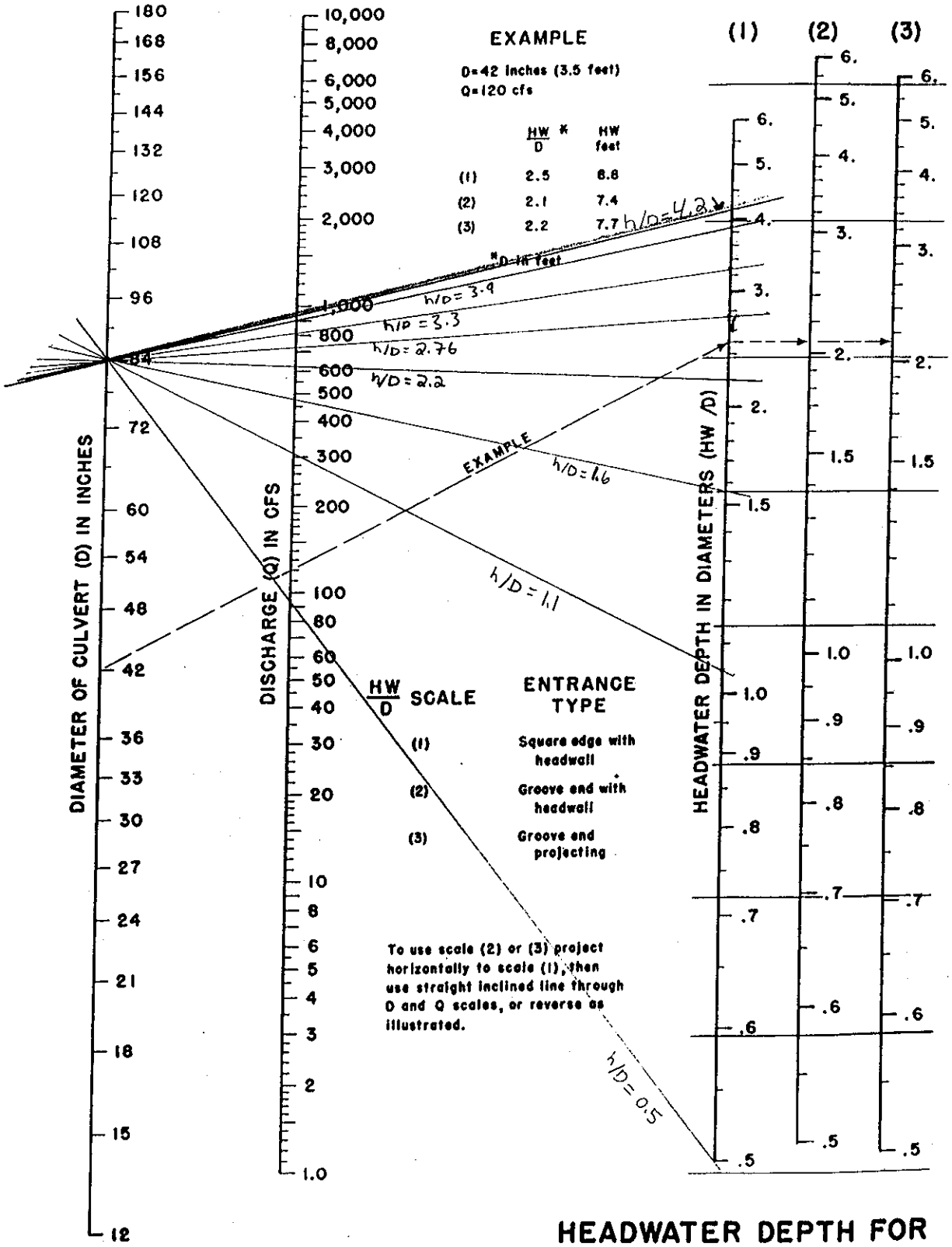
SHEET 38 OF 42
BY RAS DATE 8-20-03
CHECK CJL DATE 9-8-03

CLIENT FCDMC - Wittmann Area Drainage Master Study Update

CAP 210

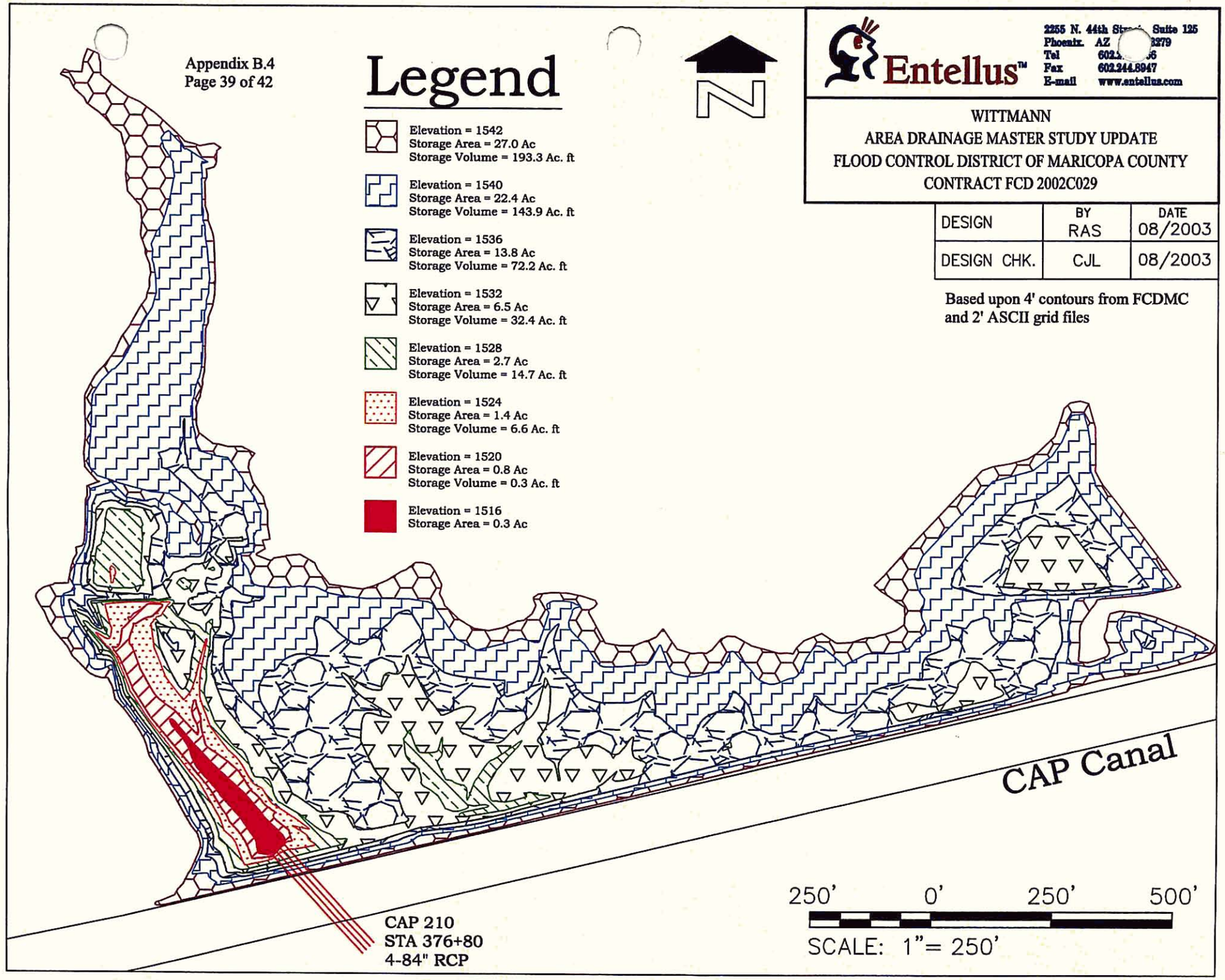
CHART 1



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003

Based upon 4' contours from FCDMC and 2' ASCII grid files

APPENDIX D.4

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SHEET	40	OF	42
BY	JS	DATE	9/8/2003
CHECK	PAW	DATE	9/10/2003
JOB NO.	310.032		

CLIENT FCDMC

JOB: Wittmann Area Drainage Master Study Update

CAP Culvert Discharge vs Water Surface Elevation/ Storage Area

Location/ Description: Impoundment Area East of US60 CAP220 Sta. 433+85 72" RCP

Diameter [inches] 72
Invert Elevation [feet] 1514.9
Berm Elevation [feet] 1540

Water Surface Elevation [ft]	h [ft]	Storage Area [acre]	Storage Volume** [acre ft]	H/D [ft/ft]	Discharge* [cfs]
1516	0	0.0	0.0	0.2	28
1520	4	0.1	0.1	0.8	155
1524	4	0.2	0.7	1.5	335
1528	4	0.5	2.1	2.2	440
1532	4	4.4	10.7	2.8	530
1536	4	15.4	48.1	3.5	600
1540	4	29.2	135.7	4.2	680
1541	1	29.2	135.7	4.3	690
1542	1	29.2	135.7	4.5	700

Water Surface Elevation [ft]	h [ft]	Weir coefficient (C)	Weir Length [ft]	Weir Discharge*** [cfs]
1541	1	2.7	2000	5400
1542	2	2.7	2000	15274

*Discharge calculated using nomograph

**Storage volume calculated using conic method, V_{12}=.333h*(A_1+A_2+(A_1*A_2)^.5)

***Weir Discharge was calculated using the equation Q_{weir}=C*L*$h^{1.5}$

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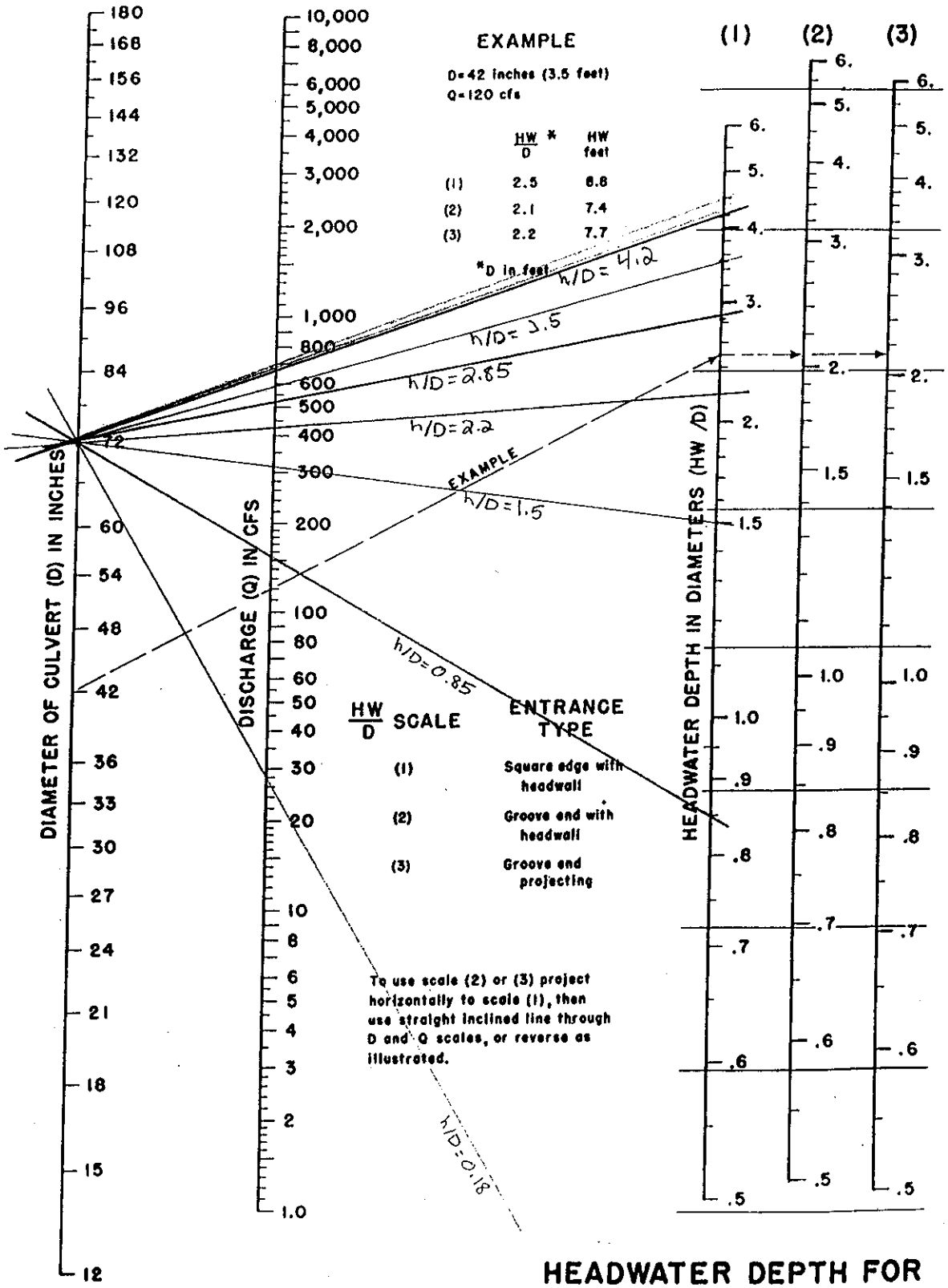
SHEET 41 OF 42
BY RAS DATE 8-19-03
CHECK CJL DATE 9-8-03

CLIENT FCDMC-Wittmann Area Drainage Master Plan Update

CAP 220

CHART 1



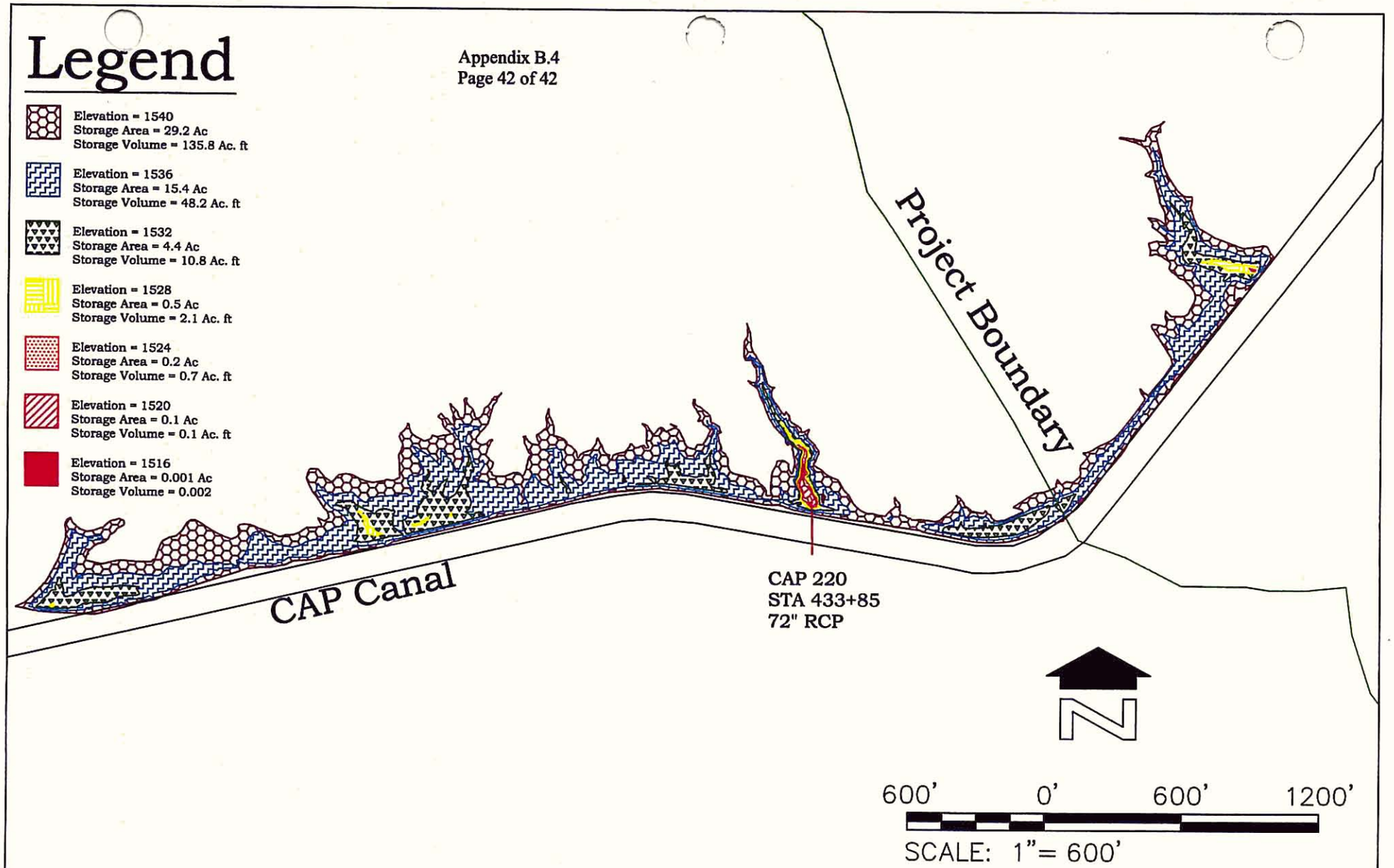
HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Legend

- Elevation = 1540
  Storage Area = 29.2 Ac
  Storage Volume = 135.8 Ac. ft
- Elevation = 1536
  Storage Area = 15.4 Ac
  Storage Volume = 48.2 Ac. ft
- Elevation = 1532
  Storage Area = 4.4 Ac
  Storage Volume = 10.8 Ac. ft
- Elevation = 1528
  Storage Area = 0.5 Ac
  Storage Volume = 2.1 Ac. ft
- Elevation = 1524
  Storage Area = 0.2 Ac
  Storage Volume = 0.7 Ac. ft
- Elevation = 1520
  Storage Area = 0.1 Ac
  Storage Volume = 0.1 Ac. ft
- Elevation = 1516
  Storage Area = 0.001 Ac
  Storage Volume = 0.002



Based upon 4' contours from
FCDMC and ASCII grid files

	BY	DATE
DESIGN	RAS	08/2003
DESIGN CHK.	CJL	08/2003

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

D.4.2. Beardsley Canal

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPI624
Bottom Width	[ft]	0
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	****
Berm Elevation	[ft]	1342
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	4305

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

* **Note:** Flow from CPI624 is isolated. It ponds and the only outlet is to overtop the canal overbank (weir flow). No flow structure exists.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1338	0.00	0	0.0	0.00	0.0	0	0	0	0.19
1340	0.00	0	0.0	0.00	0.0	0	0	0	5.86
1342	0.00	0	0.0	0.00	0.0	0	0	0	36.95
1342.5	0.00	0	0.0	0.00	0.5	0	4110	4110	36.95 [b]
1343	0.00	0	0.0	0.00	1.0	0	11624	11624	36.95 [b]
1343.5	0.00	0	0.0	0.00	1.5	0	21354	21354	36.95 [b]
1344	0.00	0	0.0	0.00	2.0	0	32876	32876	36.95 [b]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPI621
Bottom Width	[ft]	0
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	****
Berm Elevation	[ft]	1342
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	3107

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

*** Note:** Flow from CPI621 is isolated. It ponds and the only outlet is to overtop the canal overbank (weir flow). No flow structure exists.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1338	0.00	0	0.0	0.00	0.0	0	0	0	0.10
1340	0.00	0	0.0	0.00	0.0	0	0	0	1.69
1342	0.00	0	0.0	0.00	0.0	0	0	0	21.17
1342.5	0.00	0	0.0	0.00	0.5	0	2966	2966	21.17 [b]
1343	0.00	0	0.0	0.00	1.0	0	8389	8389	21.17 [b]
1343.5	0.00	0	0.0	0.00	1.5	0	15411	15411	21.17 [b]
1344	0.00	0	0.0	0.00	2.0	0	23727	23727	21.17 [b]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPD744
Bottom Width	[ft]	0
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	****
Berm Elevation	[ft]	1344
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	3652

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

* **Note:** Flow and storage from CPD744 is combined with CPI603. Weir flow is diverted back to CPD744 once the berm elevation has been exceeded.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1338	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1340	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1342	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1342.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1343	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1343.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1344	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1344.5	0.00	0	0.0	0.00	0.5	0	3486	3486	0.00 [c]
1345	0.00	0	0.0	0.00	1.0	0	9860	9860	0.00 [c]
1345.5	0.00	0	0.0	0.00	1.5	0	18115	18115	0.00 [c]
1346	0.00	0	0.0	0.00	2.0	0	27889	27889	0.00 [c]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPI603
Bottom Width	[ft]	100
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	1338
Berm Elevation	[ft]	1344
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	6487

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

* **Note:** Storage from C600A and CPD744 is combined with CPI603. Weir flow for C600A is combined with CPI603.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1336	0.00	100	0.0	0.00	0.0	0	0	0	0.00
1338	0.00	100	0.0	0.00	0.0	0	0	0	0.48
1339	0.67	100	66.6	0.33	0.0	309	0	309	2.87 [a]
1340	1.33	100	133.4	0.67	0.0	874	0	874	5.26
1341	2.00	100	200.0	1.00	0.0	1605	0	1605	16.21 [a]
1342	2.67	100	266.7	1.33	0.0	2471	0	2471	27.16
1343	3.33	100	333.3	1.67	0.0	3453	0	3453	66.56 [a]
1344	4.00	100	400.0	2.00	0.0	4539	0	4539	105.96
1344.5	4.33	100	433.3	2.17	0.5	5118	6192	11311	105.96 [b]
1345	4.67	100	466.6	2.33	1.0	5720	17515	23235	105.96 [b]
1345.5	5.00	100	500.0	2.50	1.5	6344	32177	38521	105.96 [b]
1346	5.33	100	533.3	2.67	2.0	6989	49540	56528	105.96 [b]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPD716
Bottom Width	[ft]	0
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	****
Berm Elevation	[ft]	1344
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	6745

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

*** Note:** Flow and storage from CPD716 is combined with CPD726. Weir flow is diverted back to CPD716 once the berm elevation has been exceeded.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1338	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1340	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1342	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1342.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1343	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1343.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1344	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1344.5	0.00	0	0.0	0.00	0.5	0	6439	6439	0.00 [c]
1345	0.00	0	0.0	0.00	1.0	0	18212	18212	0.00 [c]
1345.5	0.00	0	0.0	0.00	1.5	0	33457	33457	0.00 [c]
1346	0.00	0	0.0	0.00	2.0	0	51510	51510	0.00 [c]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPD726
Bottom Width	[ft]	50
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	1338
Berm Elevation	[ft]	1344
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	1283

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

* **Note:** Storage from CPD716 is combined with CPD726.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1338	0.00	50	0.0	0.00	0.0	0	0	0	0.00
1339	0.67	50	33.3	0.33	0.0	154	0	154	0.25 [a]
1340	1.33	50	66.7	0.67	0.0	437	0	437	0.50
1341	2.00	50	100.0	1.00	0.0	803	0	803	2.32 [a]
1342	2.67	50	133.3	1.33	0.0	1236	0	1236	4.14
1343	3.33	50	166.7	1.67	0.0	1727	0	1727	19.74 [a]
1344	4.00	50	200.0	2.00	0.0	2270	0	2270	35.33
1344.5	4.33	50	216.7	2.17	0.5	2559	1225	3784	35.33 [b]
1345	4.67	50	233.3	2.33	1.0	2860	3464	6324	35.33 [b]
1345.5	5.00	50	250.0	2.50	1.5	3172	6364	9536	35.33 [b]
1346	5.33	50	266.7	2.67	2.0	3494	9798	13292	35.33 [b]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET		OF	
BY		DATE	
CHECK		DATE	
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CPD704
Bottom Width	[ft]	50
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	1334
Berm Elevation	[ft]	1346
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	2308

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

* **Note:** Storage from CAF800 is combined with CPD704.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1334	0.00	50	0.0	0.00	0.0	0	0	0	0.00
1335	0.67	50	33.3	0.33	0.0	154	0	154	0.33 [a]
1336	1.33	50	66.7	0.67	0.0	437	0	437	0.65
1337	2.00	50	100.0	1.00	0.0	802	0	802	1.36 [a]
1338	2.67	50	133.3	1.33	0.0	1236	0	1236	2.07
1339	3.33	50	166.7	1.67	0.0	1727	0	1727	3.74 [a]
1340	4.00	50	200.0	2.00	0.0	2270	0	2270	5.40
1341	4.67	50	233.3	2.33	0.0	2860	0	2860	8.20 [a]
1342	5.33	50	266.7	2.67	0.0	3495	0	3495	10.99
1343	6.00	50	300.0	3.00	0.0	4170	0	4170	17.49 [a]
1344	6.67	50	333.3	3.33	0.0	4884	0	4884	23.99
1345	7.33	50	366.7	3.67	0.0	5635	0	5635	34.98 [a]
1346	8.00	50	400.0	4.00	0.0	6420	0	6420	45.97
1346.5	8.33	50	416.7	4.17	0.5	6826	2203	9029	45.97 [b]
1347	8.67	50	433.3	4.33	1.0	7239	6232	13471	45.97 [b]
1347.5	9.00	50	450.0	4.50	1.5	7660	11448	19109	45.97 [b]
1348	9.33	50	466.7	4.67	2.0	8090	17626	25715	45.97 [b]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

Entellus

SHEET	_____	OF	_____
BY	_____	DATE	_____
CHECK	_____	DATE	_____
JOB NO.	310.032		

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

Location		CAF800
Bottom Width	[ft]	0
Left Side Slope	[ft/ft]	0
Right Side Slope	[ft/ft]	0
Invert Elevation	[ft]	****
Berm Elevation	[ft]	1346
Gravity	[ft/sec^2]	32.2
Weir Coefficient (C)		2.7
Weir Length	[ft]	2281

Flow Equations Utilized

$Q_{overchute} = [(g*A_c^3)/T]^{1/2}$

where: g = Gravitational Acceleration [ft/sec^2]
A_c = Critical Area [ft^2]
T = Top Width [ft]

$Q_{weir} = C*B*H^{3/2}$

where: C = Weir coefficient
B = Weir Length [ft]
H = Water Height Over Weir [ft]

* **Note:** Flow and storage from CAF800 is combined with CPD704. Weir flow is diverted back to CAF800 once the berm elevation has been exceeded.

Stage [ft]	Critical Depth [ft]	Top Width [ft]	Area [ft^2]	Velocity Head [ft]	Height Over Weir [ft]	Overchute Discharge [cfs]	Weir Discharge [cfs]	Total Discharge [cfs]	Storage Area [ac]
1338	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1340	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1342	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1342.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1343	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1343.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1344	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1344.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1345	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1345.5	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1346	0.00	0	0.0	0.00	0.0	0	0	0	0.00 [c]
1346.5	0.00	0	0.0	0.00	0.5	0	2177	2177	0.00 [c]
1347	0.00	0	0.0	0.00	1.0	0	6159	6159	0.00 [c]
1347.5	0.00	0	0.0	0.00	1.5	0	11314	11314	0.00 [c]
1348	0.00	0	0.0	0.00	2.0	0	17419	17419	0.00 [c]

[a] Storage was only calculated for elevations where contours were available. Intermediate values were interpolated.
[b] Maximum storage was assumed at the overtopping elevation. No additional storage was assumed for overtopping.
[c] Storage for concentration point is combined with another concentration point. See note.

D.4.3. SR 74

Highway 74 Culverts

1) Summary Spreadsheet

2) Stage vs Storage or Diversion Estimations

Summary Spreadsheet

Existing Structures - State Route 74

ID #	HEC-1 CP ID	# of Barrels	Width or Diameter	Height	Type[1]	Station	Modeling Notes[2]
SR 10	CIW377	1	60"		CMP	67+50	A
20		1	42"		CMP	76+10	C,F
30		1	24"		CMP	78+25	B,D
40		1	24"		CMP	80+00	B,D
50		1	48"		CMP	86+25	B,D
60		1	60"		CMP	89+60	B,D
70		1	36"		CMP	98+50	B,D
80	CIW386	1	54"		CMP	105+00	B
90	CIW386	1	8'	7'	RCB	107+60	B,C
100		1	24"		CMP	111+20	B,D
110		1	60"		CMP	112+75	B,D
120		1	42"		CMP	117+20	B,D
130	CIW390	1	24"		CMP	121+45	B
140	CIW390	1	36"'		CMP	123+15	B
150	CIW390	1	48"		CMP	125+10	B
160	CIW390	4	12'	10'	RCB	126+45	A
170		1	30"		CMP	130+80	B,D
180		1	42"		CMP	135+00	B,D
190	CIW389	1	10'	8'	RCB	144+50	A,G
200		1	36"		CMP	154+40	B,D
210		1	42"		CMP	159+30	B,D
220		1	54"		CMP	162+30	B,D
230		1	30"		CMP	168+00	B,D
240		1	30"		CMP	169+40	B,D
250		1	36"		CMP	170+70	B,D
260		1	54"		CMP	178+50	B,D
270		1	30"		CMP	180+50	B,D
280		1	60"		CMP	183+75	B,D
290		1	24"		CMP	185+50	B,D
300		1	30"		CMP	189+95	B,D
310	CIW380	6	10'	8'	RCB	194+00	A,E
320	CTW462	3	10'	8'	RCB	198+00	A,E
330	CTW462	1	10'	8'	RCB	201+30	A,E
340		1	30"		CMP	205+50	B,D
350	CTW459	3	10'	8'	RCB	209+30	A,G
360	CTW459	1	30"		CMP	212+15	B
370		1	30"		CMP	214+00	B,D
380		1	24"		CMP	217+15	B,D
390		1	6'	7'	RCB	219+50	B,D
400		1	36"		CMP	221+75	B,D
410	C450A	1	10'	8'	RCB	231+80	A,H
420	C450A	1	6'	5'	RCB	233+90	A,H
430		1	30"		CMP	237+80	B,D
440		1	24"		CMP	243+45	B,D
450	C452A	1	10'	8'	RCB	245+80	A,G,H
460	C452A	1	10'	8'	RCB	247+70	A,G,H
470		1	30"		CMP	251+70	B,D
480		1	60"		CMP	261+25	B,D
490		1	6'	5'	RCB	266+90	B,D

Existing Structures - State Route 74

ID #	HEC-1 CP ID	# of Barrels	Width or Diameter	Height	Type[1]	Station	Modeling Notes[2]
500		1	24"		RCP	271+30	B,D
510		1	24"		RCP	274+75	B,D
520		1	6'	5'	RCB	279+65	B,D
530		1	30"		RCP	285+15	B,D
540	CTW460	4	10'	6'	RCB	289+88 to 290+32	A
550	C576A	2	10'	8'	RCB	297+70	B
560		1	36"		RCP	306+38	B,D
570		1	54"		RCP	312+00	B,D
580		1	30"		RCP	315+20	B,D
590		2	8'	5'	RCB	322+43	B,D
600		1	30"		RCP	324+40	B,D
610	C580A	1	36"		RCP	330+00	B
620	C580A	1	36"		RCP	331+60	B
630	C580A	3	10'	5'	RCB	334+15	A,E,F,I
640		1	36"		RCP	339+75	B,D
650		1	30"		RCP	341+37	B,D
660		1	48"		RCP	344+00	B,D
670		1	48"		RCP	347+60	B,D
680		1	24"		RCP	350+70	B,D
690		1	30"		RCP	351+70	B,D
700	CWI578	3	10'	4'	RCB	360+20	A
710	CWI578	1	30"		RCP	363+00	B
720	CWI578	1	60"		RCP	367+95	B
730		1	48"		RCP	371+40	B,D
740		2	8'	4'	RCB	374+85	B,D
750		1	24"		RCP	378+20	B,D
760		2	8'	7'	RCB	383+85	B,D
770	WI572	1	36"		RCP	390+70	B,H
780	WI572	2	8'	4'	RCB	392+40	A,H
790	WI572	2	4'	8'	RCB	396+50	A,H
800	CWI570	1	48"		RCP	400+35	B
810	CWI570	1	24"		RCP	402+40	B
820	CWI570	2	8'	4'	RCB	404+85	B
830	CWI566	2	10'	6'	RCB	414+45	A
840		1	36"		RCP	417+90	B,D
850		1	36"		RCP	423+50	B,D
860		1	24"		RCP	426+95	B,D
870		1	42"		RCP	433+25	B,D
880	CWI564	3	10'	5'	RCB	439+50	A,F
890		1	24"		RCP	442+60	B,D
900		1	24"		RCP	443+45	B,D
910		1	60"		RCP	446+50	B,D
920		1	8'	5'	RCB	452+90	B,D
930		1	30"		RCP	456+95	B,D
940	CWI540	3	10'	5'	RCB	460+45	A
950		1	48"		RCP	465+50	B,D
960		1	48"		RCP	471+95	B,D
970		1	30"		RCP	473+20	B,D
980		1	6'	5'	RCB	476+80	B,D

Existing Structures - State Route 74

ID #	HEC-1 CP ID	# of Barrels	Width or Diameter	Height	Type[1]	Station	Modeling Notes[2]
990		1	24"		RCP	479+10	B,D
1000		1	30"		RCP	483+20	B,D
1010		1	10'	5'	RCB	484+30	B,D
1020		1	60"		RCP	492+75	B,D
1030	CPI684	2	10'	8'	RCB	497+00	A,H
1040	CPI684	3	10'	8'	RCB	498+00	A,H
1050	CPI684	4	10'	8'	RCB	500+00	A,H
1060		1	30"		RCP	505+34	B,D
1070		1	42"		RCP	510+40	B,D
1080		1	30"		RCP	514+10	B,D
1090		1	30"		RCP	515+15	B,D
1100		1	42"		RCP	517+60	B,D
1110		1	30"		RCP	520+35	B,D
1120		1	24"		RCP	524+20	B,D
1130		1	6'	7'	RCB	530+25	B,D
1140		1	8'	7'	RCB	533+00	B,D
1150		1	6'	6'	RCB	538+70	B,D
1160		1	36"		RCP	544+40	B,D
1170		1	60"		RCP	549+60	B,D
1180		1	24"		RCP	550+90	B,D
1190		2	6'	7'	RCB	552+75	B,D
1200		1	48"		RCP	557+55	B,D
1210		1	60"		RCP	561+35	B,D
1220		1	48"		RCP	565+75	B,D
1230		1	60"		RCP	572+46	B,D
1240		1	36"		RCP	576+18	B,D
1250		1	24"		RCP	579+15	B,D
1260	CPI663	3	10'	4'	RCB	583+30	B
1270		1	42"		RCP	588+39	B,D
1280		1	42"		RCP	590+11	B,D
1290		1	60"		RCP	592+98	B,D
1300		2	6'	6'	RCB	594+00	B,D
1310		1	36"		RCP	600+47	B,D
1320		1	42"		RCP	603+90	B,D
1330		1	6'	7'	RCB	607+30	B,D
1340		1	24"		RCP	609+38	B,D
1350		1	24"		RCP	611+90	B,D
1360		1	42"		RCP	614+08	B,D
1370		1	36"		RCP	615+93	B,D
1380		1	6'	7'	RCB	620+35	B,D
1390		1	24"		RCP	624+76	B,D
1400		1	24"		RCP	627+06	B,D
1410		1	36"		RCP	631+48	B,D
1420		1	6'	5'	RCB	640+20	B,D
1430		3	10'	8'	RCB	642+70	B,D
1440		4	10'	10'	RCB	654+30	B,D
1450		1	24"		RCP	656+39	B,D
1460		1	36"		RCP	661+89	B,D
1470		1	6'	5'	RCB	662+70	B,D
1480		1	24"		RCP	664+35	B,D

Existing Structures - State Route 74

ID #	HEC-1 CP ID	# of Barrels	Width or Diameter	Height	Type[1]	Station	Modeling Notes[2]
1490		1	24"		RCP	668+78	B,D
1500		1	24"		RCP	671+86	B,D
1510		3	10'	10'	RCB	681+93	B,D
1520		2	12'	10'	RCB	683+50	B,D
1530		1	24"		RCP	688+62	B,D
1540		1	10'	6'	RCB	691+30	B,D
1550		1	6'	5'	RCB	692+55	B,D
1560		1	36"		RCP	699+12	B,D
1570		1	36"		RCP	704+48	B,D
1580		1	24"		RCP	705+75	B,D
1590		2	8'	6'	RCB	709+40	B,D
1600		1	54"		RCP	713+70	B,D
1610		1	24"		RCP	715+87	B,D
1620		1	42"		RCP	717+26	B,D
1630		1	8'	5'	RCB	720+55	B,D
1640		1	24"		RCP	726+78	B,D
1650		1	24"		RCP	731+66	B,D
1660		2	10'	8'	RCB	734+15	B,D
1670		1	24"		RCP	736+24	B,D
1680		1	42"		RCP	739+65	B,D
1690		1	24"		RCP	742+30	B,D
189		1	24"		RCP	748+74	B,D
1710		1	24"		RCP	751+15	B,D
1720		1	36"		RCP	757+10	B,D
1730		1	24"		RCP	762+80	B,D
1740		1	42"		RCP	763+50	B,D
1750		1	24"		RCP	765+60	B,D
1760		1	36"		RCP	767+55	B,D
1770		1	30"		RCP	773+10	B,D
1780		1	24"		RCP	775+85	B,D
1790		1	24"		RCP	779+50	B,D
1800		1	24"		RCP	781+30	B,D
1810		1	60"		RCP	782+95	B,D
1820		1	24"		RCP	786+25	B,D
1830		1	36"		RCP	794+34	B,D
1840		1	36"		CMP	797+80	B,D

Type Notes[1] : CMP- Corrugated Metal Pipe
RCB- Reinforced Concrete Box
RCP- Reinforced Concrete Pipe

Modeling Notes[2] : A) Modeled to maximum storage depth
B) Not modeled because storgae is negligible compared to other culverts in system
C) Not modeled because culvert conveys flow without attenuation
D) No concentration point at location
E) Diverts flow along HW 474 to downstream culvert
F) Possible roadway overtopping may occur
G) Culvert appears extremely oversized
H) Culverts work as a system
I) Culvert appears undersized

Hwy 74 at CIW377

CSL 4/5/4

SR010 —1-60" CMP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2021.3	0	0	0-NF	0	0	0	0	0	0
36	2024.02	2.48	2.72	2-M2c	2.09	1.66	1.66	0.91	6.32	3.36
72	2025.31	3.71	4.01	2-M2c	3.18	2.39	2.39	1.35	7.77	4.21
108	2026.5	4.86	5.2	2-M2c	5	2.96	2.96	1.69	8.92	4.77
160 144	2027.45	6.15	5.95	2-M2c	5	3.43	3.43	1.98	10.02	5.2
180	2029.95	7.71	8.65	2-M2c	5	3.83	3.83	2.24	11.18	5.55
216	2032.59	9.65	11.29	2-M2c	5	4.15	4.15	2.47	12.44	5.86
252	2035.52	12.02	14.22	2-M2c	5	4.42	4.42	2.68	13.76	6.12
288	2038.78	14.85	17.48	2-M2c	5	4.69	4.69	2.88	15.16	6.36
324	2042.43	18.14	21.13	2-M2c	5	4.95	4.95	3.06	16.58	6.57
360	2046.41	21.85	25.11	6-FFc	5	5	5	3.23	18.33	6.76

Concentration Point: CIW377
Prelim. Flow = 107 cfs
* overtopping elev.

Elevation (ft)	Storage (acres)	Q (cfs)
2021.3	0	0
2024	.05	36
2026	.41	100
2028*	1.98	160

SR020

PERFORM CURVE FOR CULVERT 1 - 1(3.5 (ft) BY 3.5 (ft)) CSP

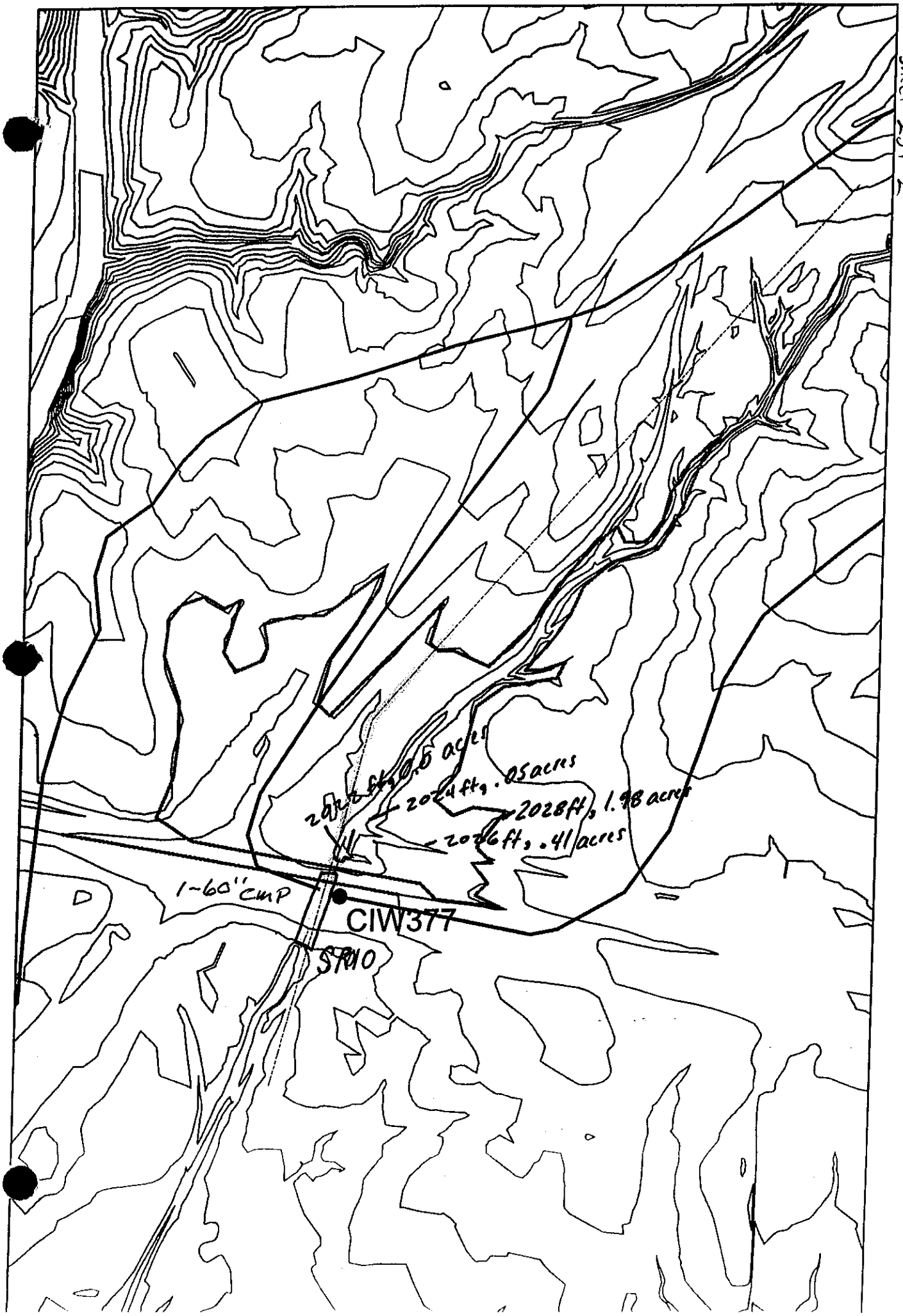
DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2028.7	0	0	0-NF	0	0	0	0	0	0
18	2030.62	1.92	1.92	1-S2n	1.2	1.29	1.09	0.62	7.09	3.55
36	2031.63	2.93	2.93	1-S2n	1.77	1.85	1.65	0.92	8.04	4.45
54	2032.93	3.97	4.23	2-M2c	2.3	2.29	2.29	1.15	8.1	5.04
72	2033.94	5.24	5.01	2-M2c	2.97	2.65	2.65	1.35	9.24	5.5
90	2035.59	6.89	6.59	2-M2c	3.5	2.92	2.92	1.52	10.52	5.88
108	2037.98	9	9.28	2-M2c	3.5	3.15	3.15	1.68	11.84	6.2
126	2040.96	11.58	12.26	2-M2c	3.5	3.38	3.38	1.83	13.33	6.48
144	2044.19	14.62	15.49	6-FFc	3.5	3.5	3.5	1.96	14.97	6.73
162	2047.83	18.07	19.13	6-FFc	3.5	3.5	3.5	2.08	16.84	6.95
180	2051.89	21.86	23.19	6-FFc	3.5	3.5	3.5	2.2	18.71	7.16

SR050

PERFORM CURVE FOR CULVERT 1 - 1(4 (ft) BY 4 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)

Sheet 1 of 2


Sheet 2 of 2
2024 ft, .05 acres
2028 ft, 1.98 acres
2026 ft, .41 acres
1-60" CMP
CIW377
STA 10

Hwy 74 at CIW390

Entellus™

SHEET 1 OF 3

BY JL DATE 3/11/4

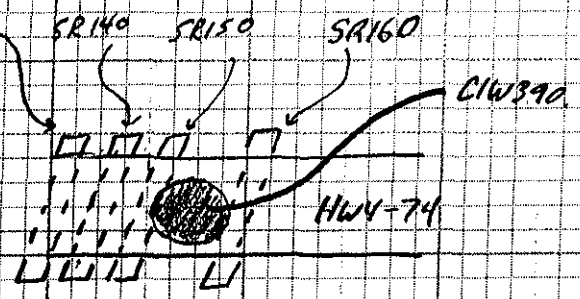
CHECK CE DATE 4/5/4

CLIENT FCD

JOB NAME Wittmann ADMSU

JOB NO. 310032

STAGE - STORAGE - DISCHARGE : CIW390



Preliminary Q @ CIW390 = 1469 cfs

		Max HWE(a)	Max HWD	Max Q
SR130:	24" CMP	Inv. = 2034	10'	45 cfs
SR140:	38" CMP	2035	9'	95
SR150:	48" CMP	2035	9'	160
SR160:	4-12' x 10' RCBC, Invert @ 2033.4 ft			5,040

Inv. = 2032.6 w/ 10' high box

NOTE: SR130, 140 and 150 were not modeled because their capacity is much less than SR160 (4.6%)

4-12' x 10' RCBC

Elevation (ft)	Storage (acre-ft)	SR1060 Q (cfs)	HW/D	Q/B	$Q_{TOT} = Q \times B$, $B = 4 \times 12' = 48'$
2036	.04	672.	.26	14	672 cfs
2038	.36	1440.	.46	30	1440
2040	3.17	2640.	.66	55	2640
2042	4.85	3840.	.86	80	3840
2044	6.69	5040.	1.06	105	5040

(assuming Inv. = 2033.4)

Q Calculated using nomograph

Sheet 2 of 3

SR160

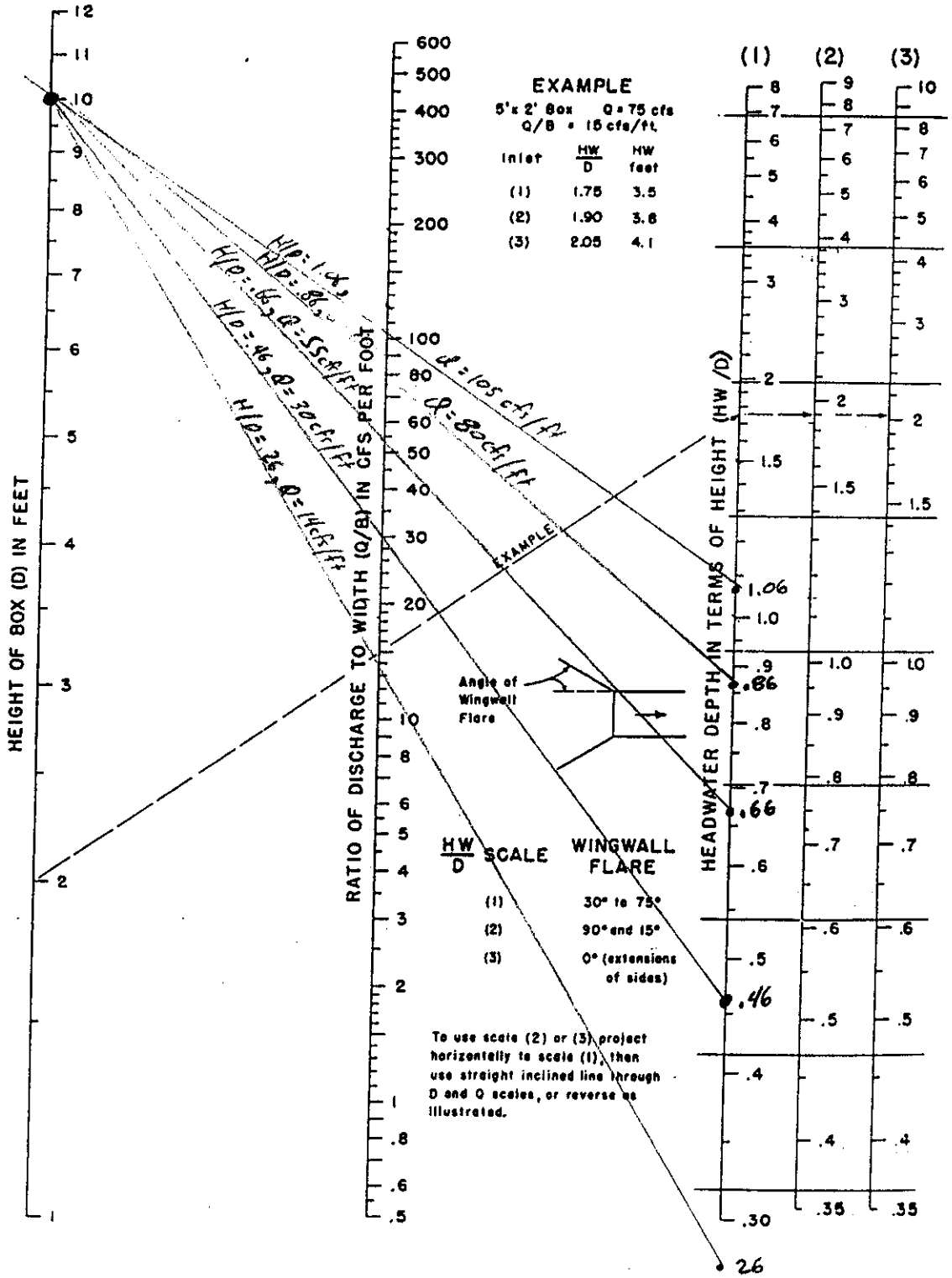
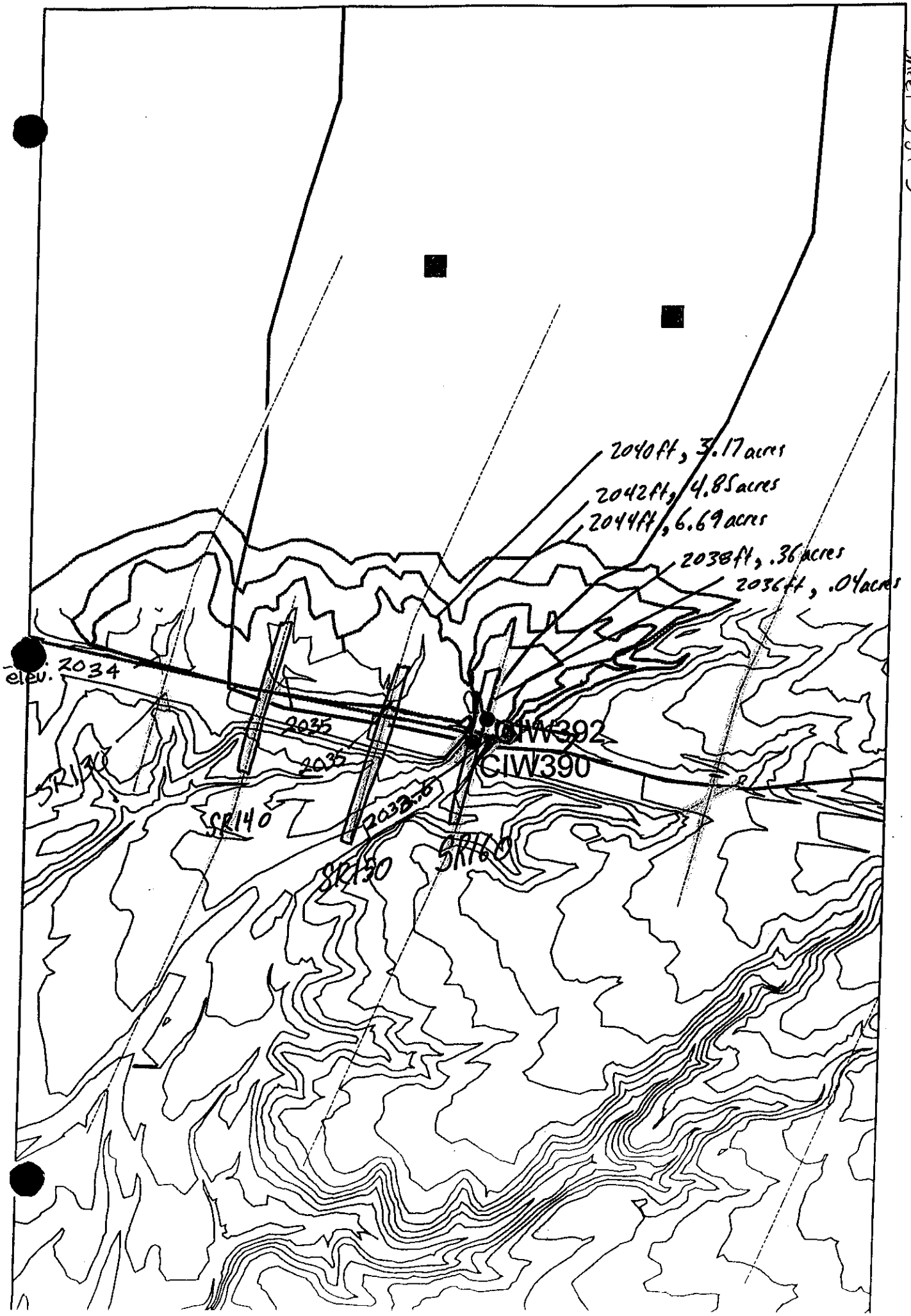


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)


2040ft, 3.17 acres
2042ft, 4.85 acres
2044ft, 6.69 acres
2038ft, .36 acres
2036ft, .04 acres
elev. 2034
2035
2035
CIW392
CIW390
SR130
SR140
2032.5
SR150
SR160

Hwy 74 at CIW389

C-4
4/5/04

0	2049.9	0	0	0-NF	0	0	0	0	0	0
16	2051.68	1.78	1.78	1-S2n	1.02	1.21	0.91	0.51	8.01	3.88
32	2052.6	2.7	2.7	1-S2n	1.48	1.75	1.35	0.77	9.34	4.88
48	2053.49	3.59	3.59	5-S2n	1.88	2.16	1.76	0.97	9.91	5.56
64	2054.52	4.62	4.62	5-S2n	2.26	2.5	2.2	1.14	10.05	6.08
80	2055.8	5.9	5.9	5-S2n	2.7	2.79	2.59	1.28	10.49	6.5
96	2057.42	7.52	5.78	2-M2c	3.5	3	3	1.42	10.98	6.87
112	2059.42	9.52	9.17	2-M2c	3.5	3.2	3.2	1.54	12.18	7.18
128	2061.84	11.88	11.94	2-M2c	3.5	3.41	3.41	1.66	13.49	7.47
144	2064.77	14.61	14.87	6-FFc	3.5	3.5	3.5	1.77	14.97	7.73
160	2068.05	17.66	18.15	6-FFc	3.5	3.5	3.5	1.87	16.63	7.96

El. inlet face invert 2049.9 ft El. outlet invert 2047.3 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR190

PERFORM CURVE FOR CULVERT 1 - 1(10 (ft) BY 8 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2053.8	0	0	0-NF	0	0	0	0	0	0
23	2054.66	0.86	0.86	1-S2n	0.19	0.55	0.25	0.45	9.24	3.02
46	2055.12	1.32	1.32	1-S2n	0.38	0.87	0.53	0.68	8.76	3.9
69	2055.53	1.73	1.73	1-S2n	0.56	1.14	0.7	0.86	9.83	4.51
92	2055.89	2.09	2.09	1-S2n	0.75	1.38	0.86	1.02	10.66	4.99
115	2056.22	2.42	2.42	1-S2n	0.87	1.6	1.02	1.16	11.22	5.39
138	2056.54	2.74	2.74	1-S2n	0.97	1.81	1.17	1.29	11.77	5.74
161	2056.83	3.03	3.03	1-S2n	1.07	2.01	1.31	1.42	12.3	6.04
184	2057.12	3.32	3.32	1-S2n	1.17	2.2	1.46	1.53	12.64	6.32
207	2057.39	3.59	3.59	1-S2n	1.27	2.37	1.59	1.64	12.98	6.57
230	2057.65	3.85	3.85	1-S2n	1.37	2.55	1.73	1.74	13.31	6.8

El. inlet face invert 2053.8 ft El. outlet invert 2052.7 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

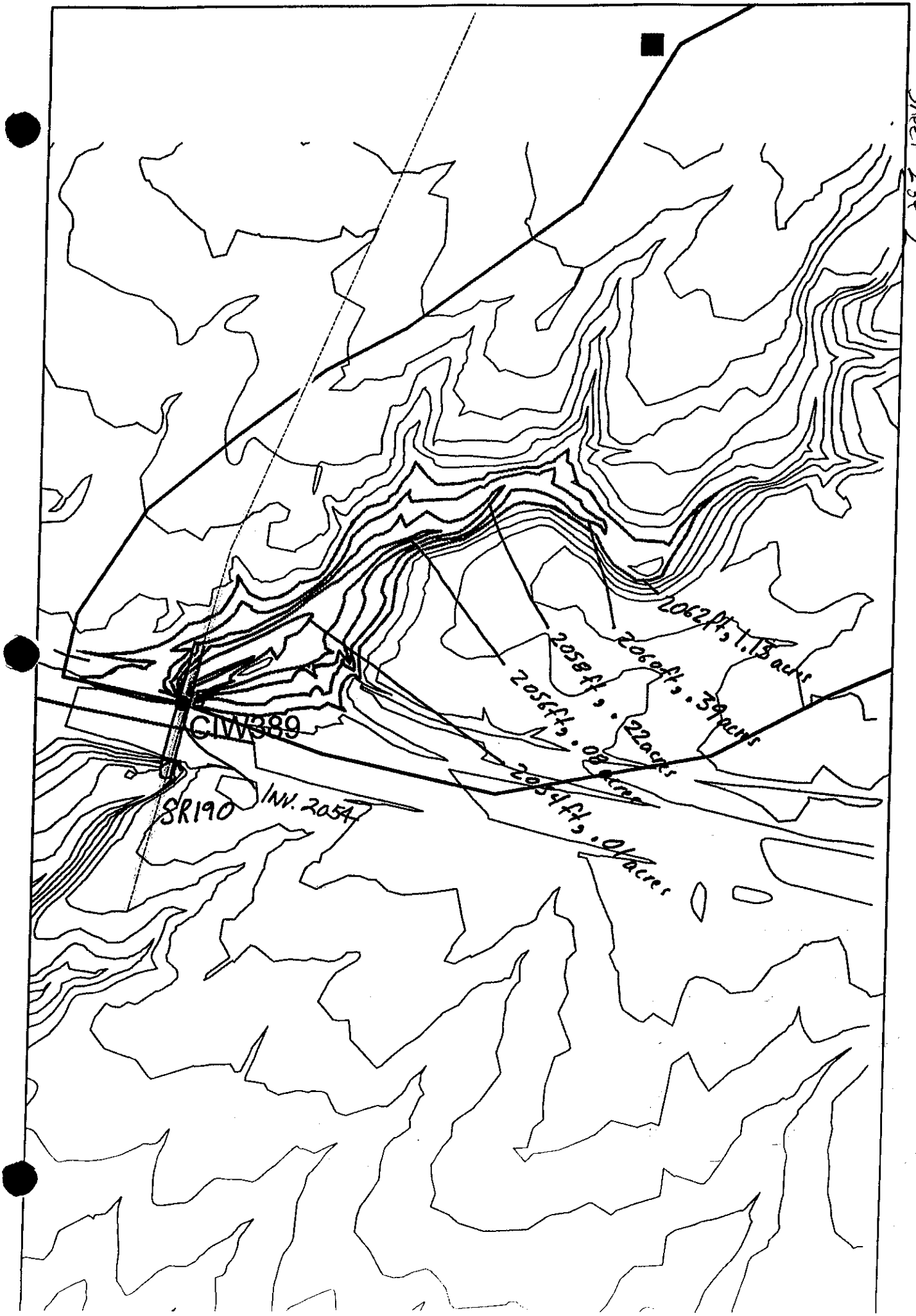
Concentration
Point: C1W389
Peak Q = 111cfs, ok not to take discharge to overtopping because culvert appears to be way oversized. Capacity ≈ 750cfs

SR210

PERFORM CURVE FOR CULVERT 1 - 1(3.5 (ft) BY 3.5 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2068.71	0	0	0-NF	0	0	0	0.41	0	0
16	2070.71	1.82	2	2-M2c	1.61	1.21	1.21	1.08	5.42	2.88

Sheet 1 of 2


Sheet 2 of 2
2062ft, 1.13 acres
2060ft, .39 acres
2058ft, .22 acres
2056ft, .08 acres
2054ft, .01 acres
CIW389
SR190
INV. 2054

Hwy 74 at CIW380

Entellus

CLIENT: FCDMC

JOB: Wittmann Area Drainage Master Study Update

SHEET _____ OF _____

BY _____ DATE _____

CHECK _____ DATE _____

JOB NO. 310.032

Discharge Calculations for CIW380 culvert and Diversion to CTW462

Location/ Description: SR310: 6 10'x8' RCB, at CIW380

Invert Elevation 2067.7

Elevation [ft]	D [ft]	HW [ft]	HW/D [ft/ft]	Q* [cfs]	Storage [ac]
2067.7	8	0	0.00	0	0
2072	8	4.3	0.54	1620	0.55
2074	8	6.3	0.79	2850	*****
2076	8	8.3	1.04	4080	3.06
2076.2	8	8.5	1.06	4200	*****
2076.5	8	8.8	1.10	4560	*****
2077	8	9.3	1.16	4740	*****
2077.5	8	9.8	1.23	5040	*****
2078	8	10.3	1.29	5400	*****
2078.5	8	10.8	1.35	5700	*****
2079	8	11.3	1.41	5940	*****
2079.5	8	11.8	1.48	6180	*****
2080	8	12.3	1.54	6540	3.07

Weir Flow Diversion to CTW462

Elevation [ft]	Weir Coefficient	Berm Elevation [ft]	H [ft]	Weir Length (B) [ft]	Q** [cfs]
2076.2	2.7	2076.2	0	175	0
2076.5	2.7	2076.2	0.3	175	78
2077	2.7	2076.2	0.8	175	338
2077.5	2.7	2076.2	1.3	175	700
2078	2.7	2076.2	1.8	175	1141
2078.5	2.7	2076.2	2.3	175	1648
2079	2.7	2076.2	2.8	175	2214
2079.5	2.7	2076.2	3.3	175	2833
2080	2.7	2076.2	3.8	175	3500

* Flows were calculated using nomograph for inlet control culverts

** Flows were calculated using the weir equation: $Q=C_w*B*H^{3/2}$

*** Based on field visit, the diversion was determined to begin at HW≈8.5, or Elevation ≈2076.2 ft

**** Storage was not included in CIW380 because the diversion prevents significant storage

***** Storage was not calculated for these elevations due to mapping limitations

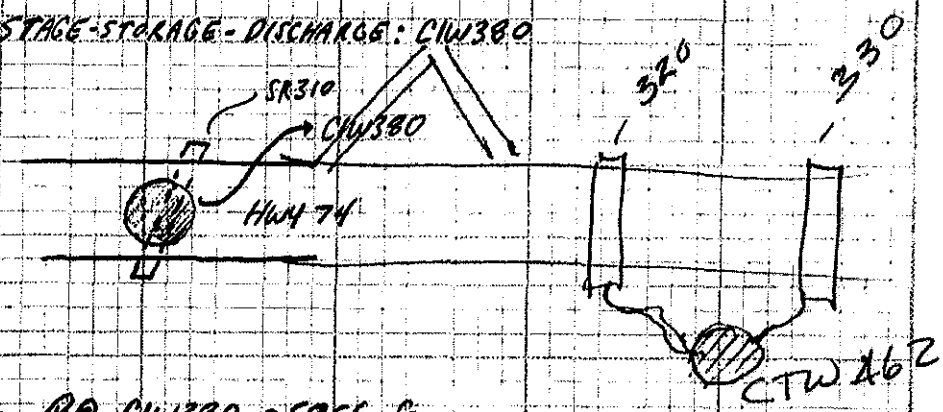
Entellus™

SHEET 1 OF 6
BY JS DATE 3/31/14
CHECK ____ DATE ____

CLIENT FCD
JOB NAME Wittmann OOMSU
JOB NO. 310032

SUPERSEDED BY FIELD VISIT.
SEE DISCHARGE CALCULATIONS SPREADSHEET

STAGE-STORAGE-DISCHARGE: CIW380



Preliminary Q@ CIW380 = 5956 cfs

SR310: 6 - 10' x 8' RBC, Invert @ 2067.7 ft

Overtopping elev. assume 2078.0 not possible.
~~(Hit at top plus 2.0' headwall + 0.3')~~

Elevation (ft)	Storage (acres)	SR310 Q (cfs)
2067.7	0	0
2072	.55	1620
2073.7 (Max elev.)	.[illegible]	1980
~~2076~~	~~2.06~~ 2	~~4200~~
~~2078~~	~~3.06~~	~~4500~~
2076.5		4500

per ADOT plans
Max HWD = 5.0' above Invert
Flow above that would overtop the berm to the east to culv 320 and 310.
~~= 70cfs/ft x 6 x 20'~~
~~= 85cfs/ft x 6 x 70'~~

1 Estimated using nomograph
2 Max Storage

This appears to have be designed to over flow to 320 and 330 at CTW 462.

The photos from the survey show that they all three are active flow carriers.

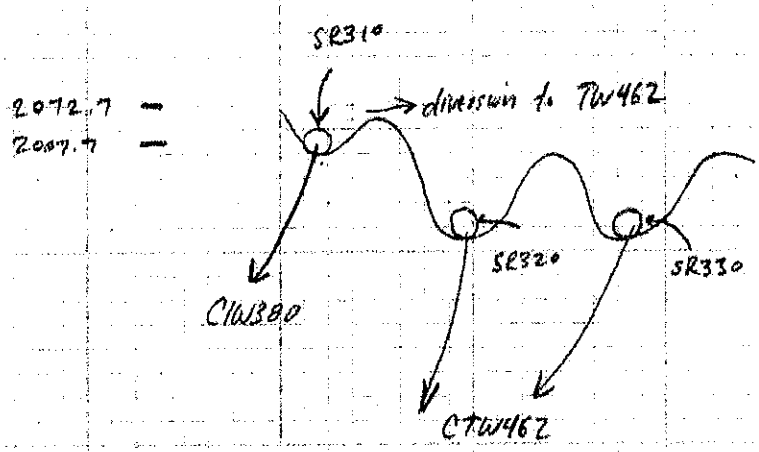
Need to have a divert from CIW 380 to CTW 462.

Entellus™

SHEET 2 OF 6
BY JS DATE 4/7/14
CHECK ____ DATE ____

CLIENT FCD
JOB NAME Wittmann QOMSU JOB NO. 310.032

STAGE / DIVERSION: CIW380 → CTW462



DIVERSION TO TW462 MODELED AS WEIR

C = 3.2
L = 175
H = varies with E, Q = CLH^3/2
E = WSE - 2072.7 ft

WSE	H	Q diversion	Q SR310 (from other sheet)
2072.7	0	0	1980
2076	3.3	3357	4200
2076.5	3.8	4148	4500

Diversion from CIW380 → CTW462

DI	0	1680	1980	7557	8648
DQ	0	0	0	3357	4148

SUPERSEDED BY FIELD VISIT: SEE DISCHARGE CALCULATIONS SPREADSHEET

Sheet 3 of 6

SR310

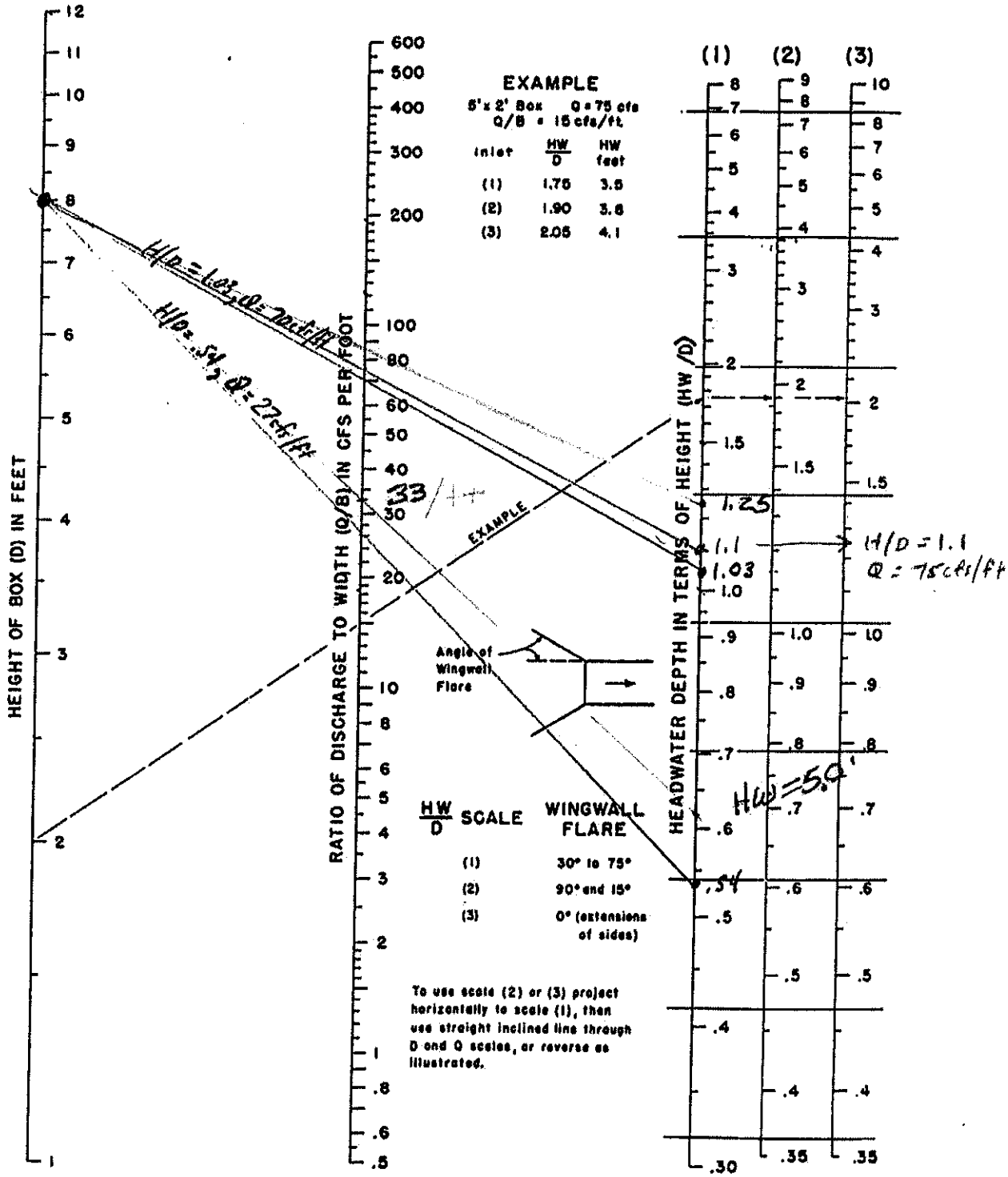
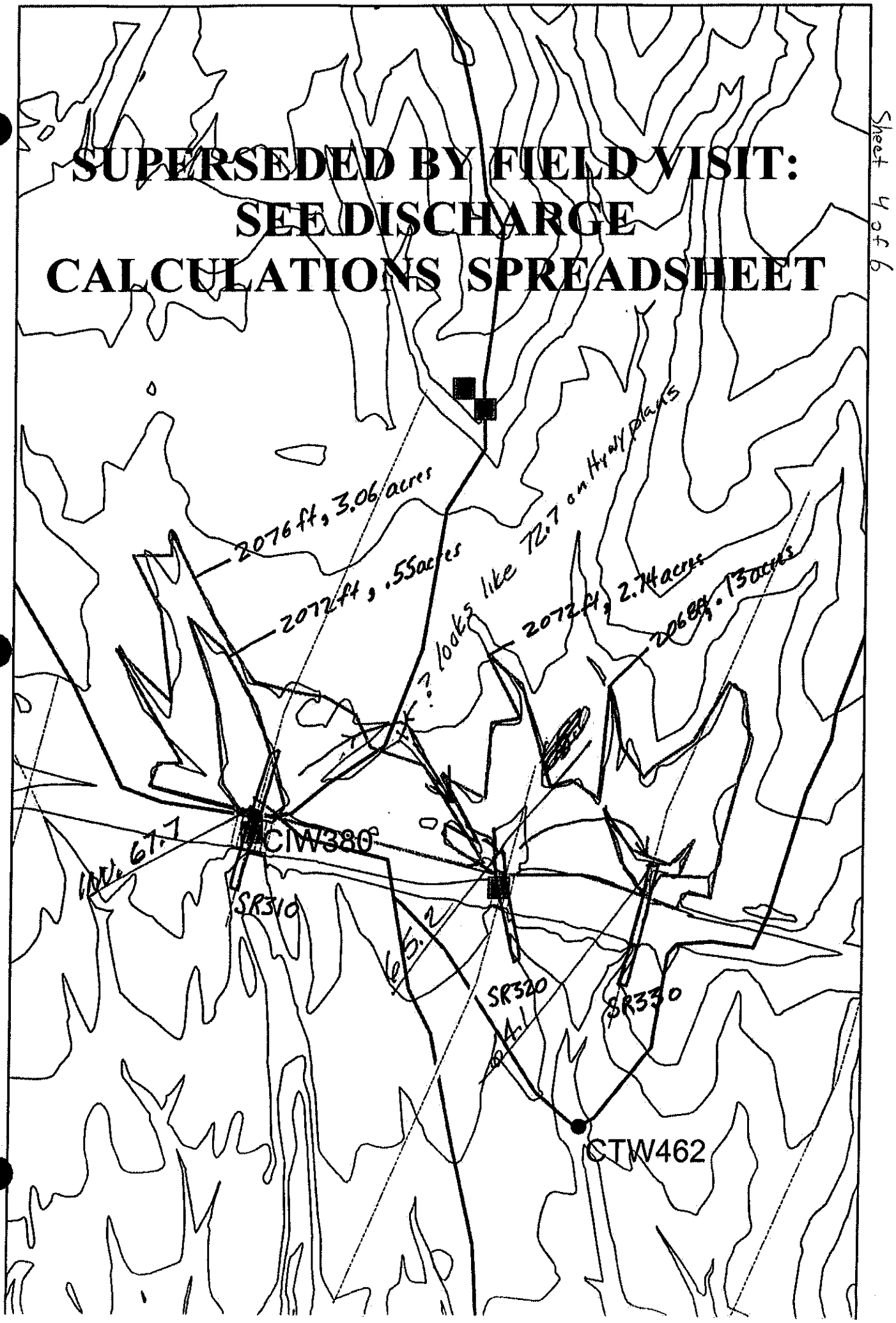


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

SUPERSEDED BY FIELD VISIT: SEE DISCHARGE CALCULATIONS SPREADSHEET



MORRISTOWN – NEW RIVER HWY.
MORRISTOWN EAST UNIT I
MARICOPA COUNTY

From USGO
As builts

New Conc. Emb. Curb, Std. C-3 - Future
Lt. Sta. 180+00 to 201+75 - 2175 Lin. Ft.
Lt. Sta. 205+00 to 205+75 - 75 Lin. Ft.
Lt. Sta. 208+00 to 210+00 - 200 Lin. Ft.

Lt. Sta. 189+ 1+48' New

Future 190+50
Lt. Sta. 180+00 to 189+88
988' New 4-Wire Fence. Std. C-16.

1050'

105' New Bank Protection.
Std. C-23. Type "A".

Sta. 183+75 C.I.P.
New 60"x102' Pipe Culv.

POT 184+50

This. Contract
New #2 Gate (Temporary)
Std. C-16

New R/W

New Dyke

27'-0"

S 77° 51' 10" E

2644.87'

New R/W

Sta. 180+50
New 30"x104' Pipe Culv.
C.M.P.

Sta. 185+50 C.M.P.
New 24"x100' Pipe Culv.

S 89° 57' 45" E

Sta. 189+95 C.I.P.
New 30"x120' Pipe Culv.
Skew 45° Lt.

Sta. 193+85 to Sta. 194+50.83
New 6'-10'x8'x57' Box Culv.
Std. CI-10-6.

Found ¼ corner
1" Iron pipe with B.C.
USGLO - 1916
No BTs.

Future
Rt. Sta. 180+00 to Sta. 210+00
3030' New 4-Wire Fence.
Std. C-16 & C-16-A

B.M. Brass Cap. Rt. Cu
Sta. 194+07 Elev. 204

PUBLIC DOMAIN

Match A

B.M. #18.5-5/8" I.P. in Conc. 100' Rt.
Sta. 185+00, Elev. 2074.21

B.M. #19.6-5/8" I.P. in
Sta. 196+00, Elev.

New 135' Gr. Ditch Lt.

New 325'
New 250' Gr. Dk. Lt.

New 50' Gr. Dk. Lt.

Future
Fin. Gr. Grade

First Ground Line

Max H

2000' V.C.

300' Unlimited

Finish Plane E.E.R. 9-25-63

PLAN

From Str.	
Drain	1140.0
15" Str.	1210
Bor.	25.097.4
15" Str.	2066
Drain	2064.4
End Comp.	1850.4

180 81 82 83 84 185 86 87 88 89 190 91 92 93 94

270 280 290 300

B.P.R. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
7	ARIZ.	S-434(1)	10	13	Nov. 1960 12-21-6

Sheet 6 of 6

to Sta. 199+20.
Wire Fence. Std. C-16.

next elev. here

From USGS as builts

105' New Bank Protection.
Std. C-23. Type "A."

60' Drainage Easement.

Future.
Sta. 199+20 to Sta. 210+00
111.0' New 4-Wire Fence.
Std. C-16 & C-16-A

T6N R3W

Found Section Corner
2" iron pipe with B.C.
U.S.G.L.O.-1916
No B.Ts.

Remove Exist. Fence within R/W

New Dike

New Dike

POT 196+00

Berm Lt.

12°06'35"

12.63.92

Survey & Constr. ℄

Sta. 207+48.75
Section Line

271.19

33'-6"

100'

100'

Sta. 194+55.87 Sec. Line

Sta. 198+63 to Sta 198+96.33
New 3-10'×8'×58'-6" Box Culv.
Std. C1-10-3.

Sta. 205+50 CMP
New 30"×102'-Pipe Culv.

Sta. 201+30
New 10'×8'×54' Box Culv.
Std. C1-10-1.

POT 207+86.0

2640.14

N 0°00'45" W

Sta. 207+08 to Sta. 209+41.33
New 3-10'×8'×69'-6" Box Culv. Std. C-1-10-3

B.M. Brass Cap. Rt. Curb.
Sta 198+80 Elev. 2071.99

Match A

New Conc. Emb. Curb, Std. C-3-Future
Rt. Sta. 180+00 to 201+75 - 2175 Lin. Ft.
Rt. Sta. 202+85 to 206+35 - 350 Lin. Ft.
Rt. Sta. 208+25 to 210+00 - 175 Lin. Ft.

B.M. Brass Cap. Rt. Curb.
Sta. 209+24 Elev. 2069.29

B.M. Brass Cap. Rt. Curb.
Sta. 201+30 Elev. 2070.96

Found 1/4 corner
1" iron pipe with B.C.
U.S.G.L.O. - 1916
No B.Ts.

B.M. #207-5/6" I.P. in Conc. 100' Rt.
Sta. 207+00. Elev. 2066.43

TRIBY WASH

40' ROADWAY

New 385' Grader Ditch Rt.

New 1,860' Grader Ditch Rt.

Top of 10' Berm Lt.
Elev. 2072.00

Fl. Elev. 2065.10
Slope 1.62% Rt.

Fl. Elev. 2062.50
Slope 1.92% Rt.

Fl. Elev. 2061.50
Slope 1.99% Rt.

Fl. Elev. 2059.00
Slope 2.02% Rt.

2080
2070
2060
2050

50' 2.000'e 1% Vert. 2070 2065 5.0

REDUCED SIZE

Sta. 207+50 to Sta. 209+41.33
New 3-10'×8'×69'-6" Box Culv.
100 C.Y. Dam. Gravel
60 C.Y. Ft. Gravel

Excav. 471.5
15% Shr. 70.7
From Shrc.
Excav. 1,330.0
15% Shr. 199.5
Emb. 12,550.0
Std. Comp. 445.0
1970 Lin. 2,956.5
15% Shr. 443.5
Total Lin. 10,450.0
10% Shr. 1,045.0
Incl. Sc. Dykes & Berm

2,636.5 C.Y. 0.450 Mi. = 1,086.4 C.Y./Mi.
From Sta. 238+69

1,442.7 C.Y. 0.285 Mi. = 888.0 C.Y./Mi.
From Sta. 228+45

From Rt. 800 Lt.
207+00

96 97 98 99 200 01 02 03 04 205 06 07 08 09 210

AN-PROFKE & ELLIS CO.

Hwy 74 at CTW462

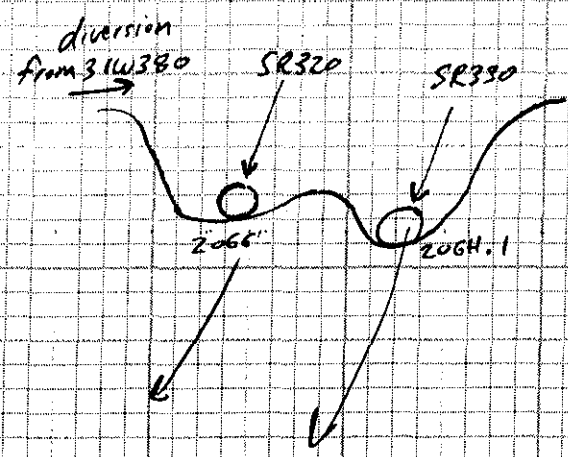
Entellus™

SHEET 1 OF 4
BY JS DATE 4/7/4
CHECK ____ DATE ____

CLIENT FCD

JOB NAME Wittmann ADMSH JOB NO. 310032

Stage / Storage - Discharge : CTW462



CTW462

WSE	QSR320	QSR330	Q total	Storage acres
2064.1	0	0	0	
2068	216	220	436	.13
2072*	1350	650	2000	2.74*

* Max Storage
+ Max Stage before overtopping

1080	2070.98	3.28	3.28	1-S2n	1.22	2.16	1.5	3.89	11.97	10
1200	2071.21	3.51	3.51	1-S2n	1.31	2.32	1.62	4.12	12.34	10.32

El. inlet face invert 2067.7 ft El. outlet invert 2066.8 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR320

PERFORM CURVE FOR CULVERT 1 - 3(10 (ft) BY 8 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2066	0	0	0-NF	0	0	0	0	0	0
54	2066.35	0.35	0.35	1-S2n	0.21	0.47	0.27	0.75	6.76	3.33
108	2066.71	0.71	0.71	1-S2n	0.42	0.74	0.44	1.14	8.18	4.27
162	2066.94	0.94	0.94	1-S2n	0.63	0.97	0.72	1.44	7.52	4.92
→ 216	2068.05	1.14	2.05	3-M1t	0.82	1.17	1.7	1.7	4.23	5.42
270	2068.37	1.33	2.37	3-M1t	0.93	1.36	1.94	1.94	4.65	5.84
324	2068.69	1.52	2.69	3-M1t	1.04	1.54	2.15	2.15	5.02	6.2
378	2069.02	1.69	3.02	3-M1t	1.15	1.71	2.35	2.35	5.36	6.52
432	2069.14	1.84	3.14	3-M1t	1.26	1.86	2.53	2.53	5.68	6.8
486	2069.46	1.99	3.46	3-M1t	1.37	2.02	2.71	2.71	5.98	7.06
540	2069.79	3.8' 2.14	3.79	3-M1t	1.47	2.16	2.87	2.87	6.26	7.3

Max HWD = 7.5' per ADOT

El. inlet face invert 2066 ft -65.2 El. outlet invert 2065.5 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR330

PERFORM CURVE FOR CULVERT 1 - 1(10 (ft) BY 8 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2064.1	0	0	0-NF	0	0	0	0	0	0
20	2064.91	0.81	0.81	1-S2n	0.19	0.5	0.2	0.4	10	2.43
40	2065.3	1.2	1.2	1-S2n	0.38	0.79	0.49	0.6	8.1	3.16
60	2065.68	1.58	1.58	1-S2n	0.57	1.04	0.68	0.76	8.85	3.66
→ 80	2066.01	1.91	1.91	1-S2n	0.76	1.26	0.83	0.9	9.64	4.07
100	2066.32	2.22	2.22	1-S2n	0.88	1.46	0.97	1.03	10.29	4.41
120	2066.6	2.5	2.5	1-S2n	0.98	1.65	1.11	1.15	10.8	4.7
140	2066.88	2.78	2.78	1-S2n	1.08	1.83	1.25	1.25	11.2	4.96
160	2067.13	3.03	3.03	1-S2n	1.18	2	1.37	1.36	11.68	5.2
180	2067.38	3.28	3.28	1-S2n	1.28	2.16	1.5	1.45	11.97	5.41
200	2067.62	3.5' 3.52	3.52	1-S2n	1.38	2.32	1.62	1.54	12.34	5.61
220	2068	3.9	64.1							
650	2072	7.9								

from nomogram

Concentration Point: CTW462
Qprelim = 125 cfs
Max HWD 8.5' per ADOT

Conclusion: Capacity of SR320 - SR330 is much greater than the prelim. flow ∴ Storage is negligible.

Storage will be included after division

I think because it is designed to take over-flow → see attached

Sheet 2 of 4

Sheet 3 of 4

CTW462

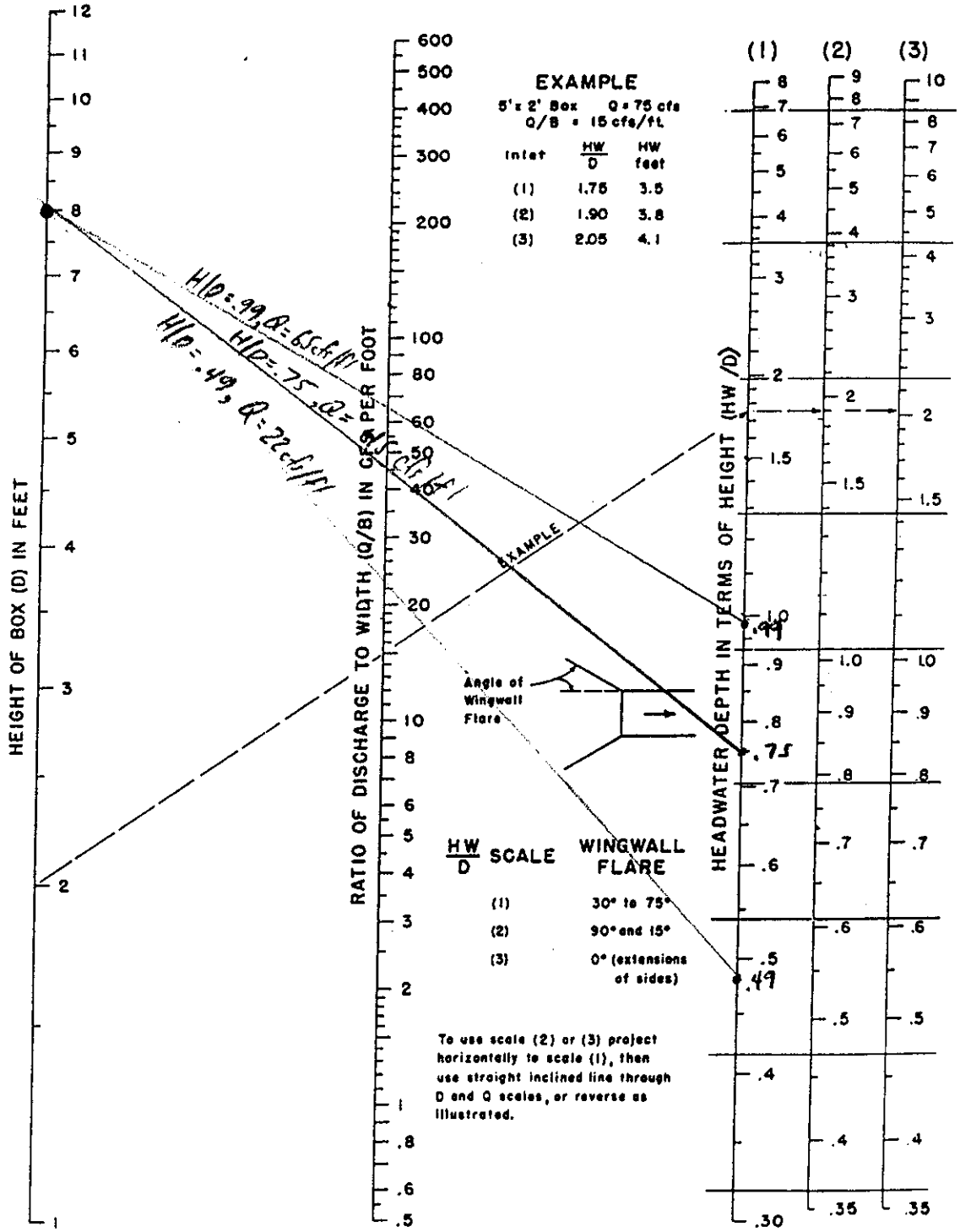
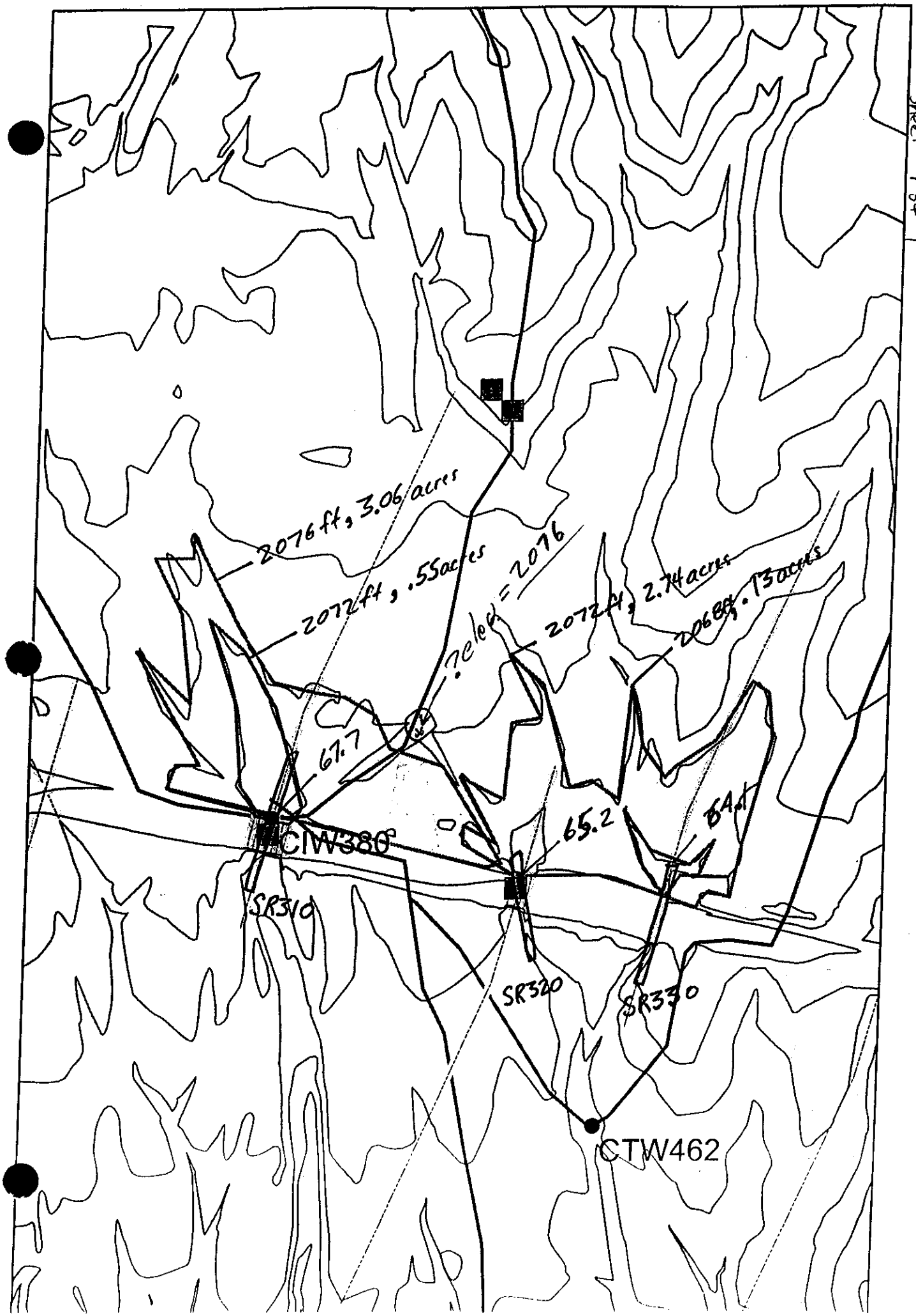


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)


2076 ft, 3.06 acres
2072 ft, .55 acres
?elev = 2076
2072 ft, 2.74 acres
2068 ft, .13 acres
67.7
65.2
64.1
CIW380
SR310
SR320
SR330
CTW462

Hwy 74 at CTW459

Entellus™

SHEET 1 OF 4

BY [illegible] DATE 3/31/14

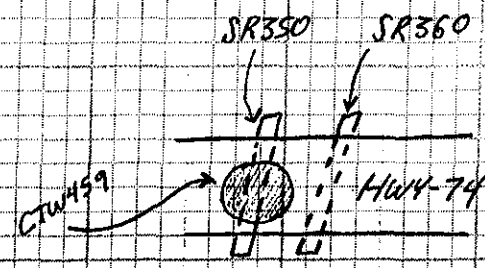
CHECK [illegible] DATE 4/6/14

CLIENT FCD

JOB NAME Withmann ADMSU

JOB NO. 310032

STAGE - STORAGE - DISCHARGE: CTW459



Preliminary Q@ CTW459 = 359 cfs

SR350: 3 - 10' × 8' RCBC, Invert at 2058 ft

SR360: 30" CMP

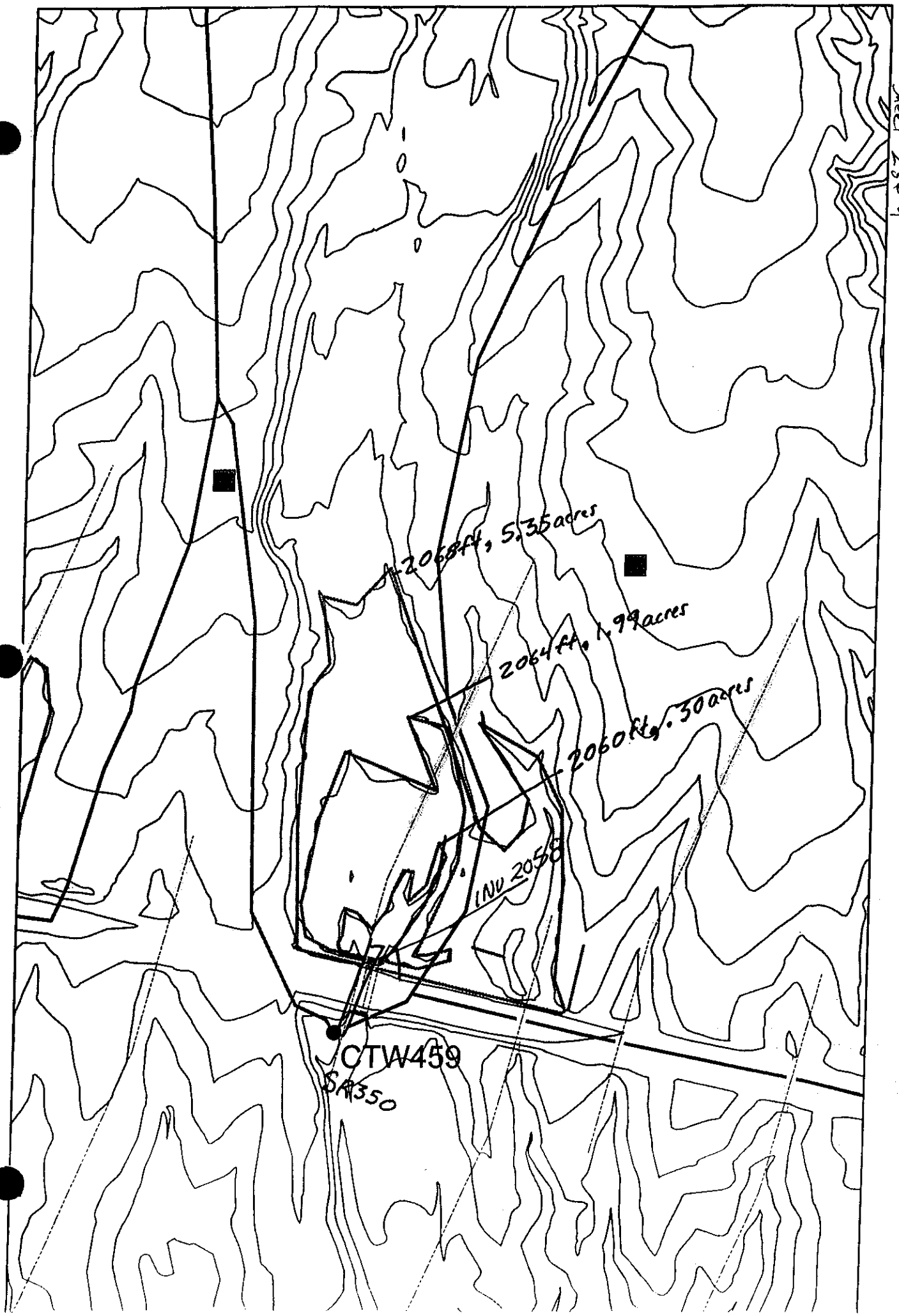
NOTE: SR360 was not modeled because its capacity is much less than the capacity of SR350

Max HWD = 10 ft.

Elevation (ft)	Storage (acres)	SR350 Q (cfs)
2058	0	0
2060	.30	468 1
2064	1.99	1350 2
2068	5.35	2550 2

1 Estimated using H48

2 Estimated using nomogram


2068ft, 5.35acres
2064ft, 1.99acres
2060ft, .30acres
INV 2058
CTW459
SA350

Sheet 2 of 4

Sheet 3 of 4

CTW459

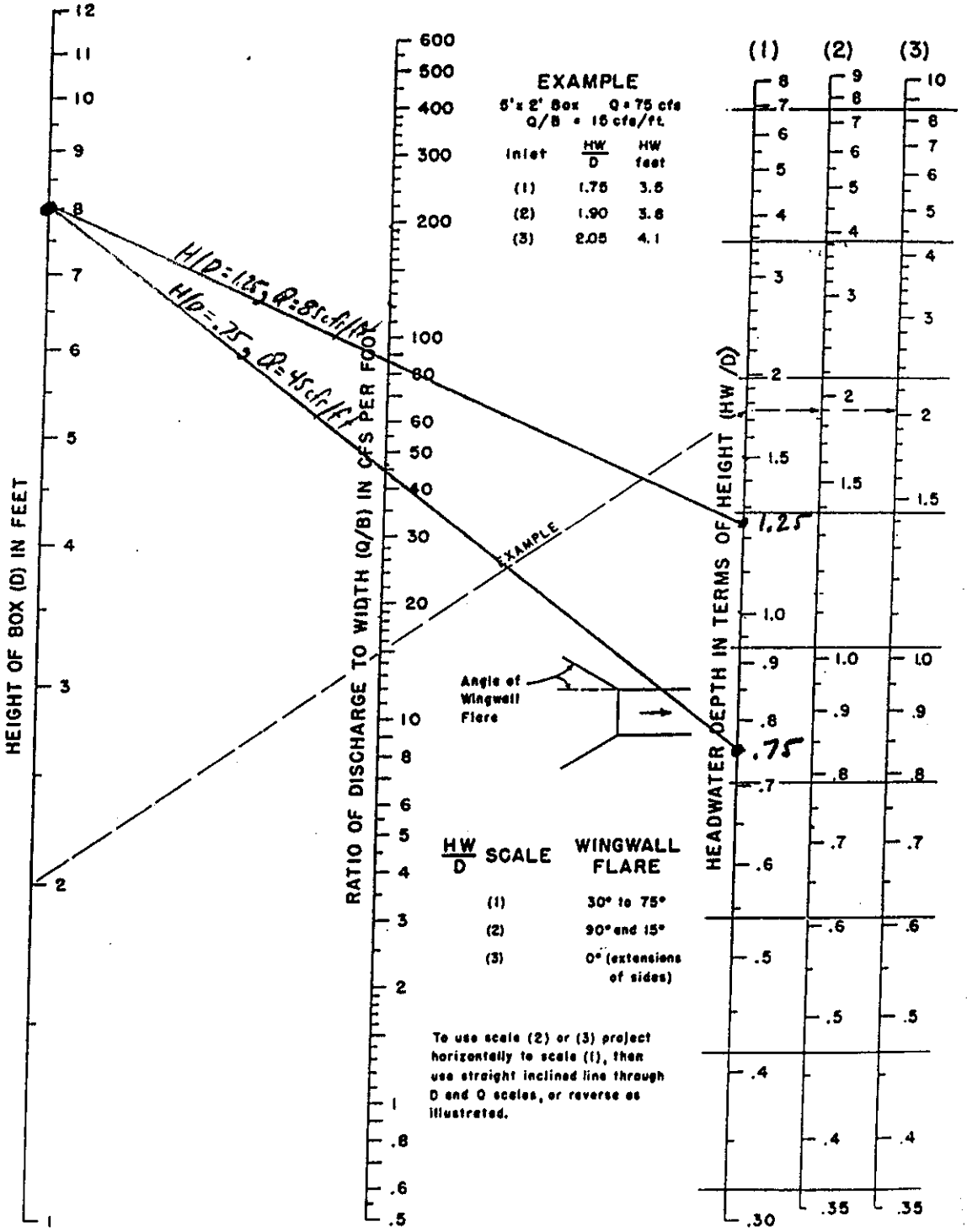


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

Sheet 4 of 4

STATE ROUTE 74-CULVERT ANALYSIS

El. inlet face invert 2064.1 ft El. outlet invert 2063.1 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR350

PERFORM CURVE FOR CULVERT 1 - 3(10 (ft) BY 8 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2058	0	0	0-NF	0	0	0	-2.1	0	0
78	2058.51	0.51	0.51	1-S2n	0.22	0.6	0.3	-1.27	8.8	4.36
156	2058.92	0.92	0.92	1-S2n	0.43	0.95	0.57	-0.86	9.2	5.58
234	2059.2	1.2	1.2	1-S2n	0.65	1.24	0.76	-0.52	10.28	6.41
312	2059.48	1.48	1.48	1-S2n	0.84	1.5	0.93	-0.24	11.17	7.06
390	2059.72	1.72	1.72	1-S2n	0.95	1.74	1.1	0.02	11.8	7.6
468	2059.94	1.94	1.94	1-S2n	1.06	1.97	1.27	0.25	12.32	8.06
546	2060.15	2.15	2.15	1-S2n	1.18	2.18	1.42	0.47	12.82	8.47
624	2060.37	2.37	2.37	1-S2n	1.29	2.38	1.57	0.67	13.23	8.83
702	2060.56	2.56	2.56	1-S2n	1.4	2.58	1.72	0.86	13.63	9.16
780	2060.74	2.74	2.74	1-S2n	1.52	2.76	1.86	1.04	13.94	9.47

Concentration Point: CTW459

El. inlet face invert 2058 ft El. outlet invert 2056.7 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR390

PERFORM CURVE FOR CULVERT 1 - 1(6 (ft) BY 7 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2054.8	0	0	0-NF	0	0	0	0	0	0
20	2055.85	1.05	1.05	1-S2n	0.23	0.7	0.35	0.41	9.39	3.77
40	2056.47	1.67	1.67	1-S2n	0.47	1.12	0.58	0.62	11.58	4.84
60	2056.98	2.18	2.18	1-S2n	0.7	1.46	0.78	0.79	12.79	5.59
80	2057.44	2.64	2.64	1-S2n	0.83	1.77	0.97	0.94	13.73	6.16
100	2057.87	3.07	3.07	1-S2n	0.96	2.06	1.16	1.06	14.43	6.65
120	2058.27	3.47	3.47	1-S2n	1.08	2.32	1.34	1.18	14.91	7.06
140	2058.66	3.86	3.86	1-S2n	1.21	2.57	1.52	1.29	15.33	7.43
160	2059.03	4.23	4.23	1-S2n	1.34	2.81	1.69	1.4	15.76	7.76
180	2059.39	4.59	4.59	1-S2n	1.45	3.04	1.84	1.49	16.29	8.05
200	2059.73	4.93	4.93	1-S2n	1.56	3.26	2.01	1.58	16.56	8.33

El. inlet face invert 2054.8 ft El. outlet invert 2052.6 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR410

Hwy 74 at C450A

Entellus™

SHEET 1 OF 4

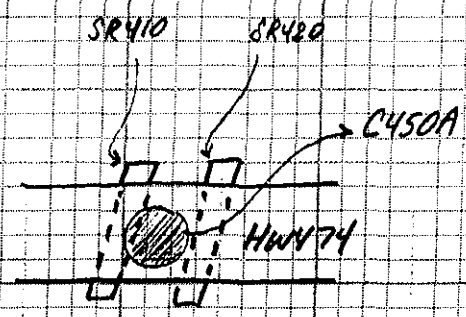
BY JS DATE 4/1/4

CHECK CJL DATE 4/6/4

CLIENT FCD

JOB NAME Wittmann Commu JOB NO. 310032

STAGE - STORAGE - DISCHARGE: C450A



Preliminary Q @ C450A = 659 cfs

SR410: 1 - 10' x 8' RBC, Invert @ 2049.8 ft

SR420: 1 - 6' x 5' RBC, Invert @ 2048.7 ft

ELEVATION (ft)	STORAGE (acres)	SR410 Q (cfs)	SR420 Q (cfs)	TOTAL Q (cfs)
2048.7	0	0	0	0
2049.8	0	0	30	30
2054	.884	250₂	210₂	360
2058	3.7*	700₂	372₂	1072
2060	3.7			10,000 (overtopping)

1 Estimated using H48

2 Estimated using Nomogram

* Max Storage

10

PERFORM CURVE FOR CULVERT 1 - 1(10 (ft) BY 8 (ft)) RCB

Concentration Point: C450A

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2049.8	0	0	0-NF	0	0	0	0	0	0
18	2050.58	0.78	0.78	1-S2n	0.22	0.47	0.27	0.45	6.76	2.38
36	2050.93	1.13	1.13	1-S2n	0.43	0.74	0.44	0.68	8.18	3.07
54	2051.28	1.48	1.48	1-S2n	0.65	0.97	0.73	0.86	7.43	3.55
72	2051.59	1.79	1.79	1-S2n	0.83	1.17	0.88	1.01	8.14	3.93
90	2051.88	2.08	2.08	1-S2n	0.95	1.36	1.03	1.16	8.71	4.25
108	2052.14	2.34	2.34	1-S2n	1.06	1.54	1.18	1.29	9.16	4.52
126	2052.4	2.6	2.6	1-S2n	1.17	1.71	1.32	1.41	9.58	4.76
144	2052.64	2.84	2.84	1-S2n	1.29	1.86	1.44	1.52	9.97	4.98
162	2052.87	3.07	3.07	1-S2n	1.4	2.02	1.58	1.63	10.27	5.17
180	2053.1	3.3	3.3	1-S2n	1.51	2.16	1.7	1.73	10.57	5.36

El. inlet face invert 2049.8 ft El. outlet invert 2049.3 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR420

PERFORM CURVE FOR CULVERT 1 - 1(6 (ft) BY 5 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2048.65	0	0	0-NF	0	0	0	0	0	0
14	2049.49	0.84	0.84	1-S2n	0.33	0.55	0.39	0.5	6.03	2.53
28	2049.99	1.34	1.34	1-S2n	0.58	0.88	0.61	0.76	7.59	3.22
42	2050.4	1.75	1.75	1-S2n	0.76	1.15	0.81	0.96	8.61	3.69
56	2050.77	2.12	2.12	1-S2n	0.93	1.4	1	1.13	9.37	4.05
70	2051.11	2.46	2.46	1-S2n	1.08	1.62	1.18	1.28	9.88	4.35
84	2051.44	2.79	2.79	1-S2n	1.22	1.83	1.35	1.42	10.37	4.61
98	2051.75	3.1	3.1	1-S2n	1.36	2.03	1.51	1.55	10.83	4.84
112	2052.04	3.39	3.39	1-S2n	1.5	2.22	1.67	1.67	11.2	5.04
126	2052.32	3.67	3.67	1-S2n	1.62	2.4	1.82	1.78	11.55	5.22
140	2052.59	3.94	3.94	1-S2n	1.74	2.57	1.97	1.89	11.83	5.39

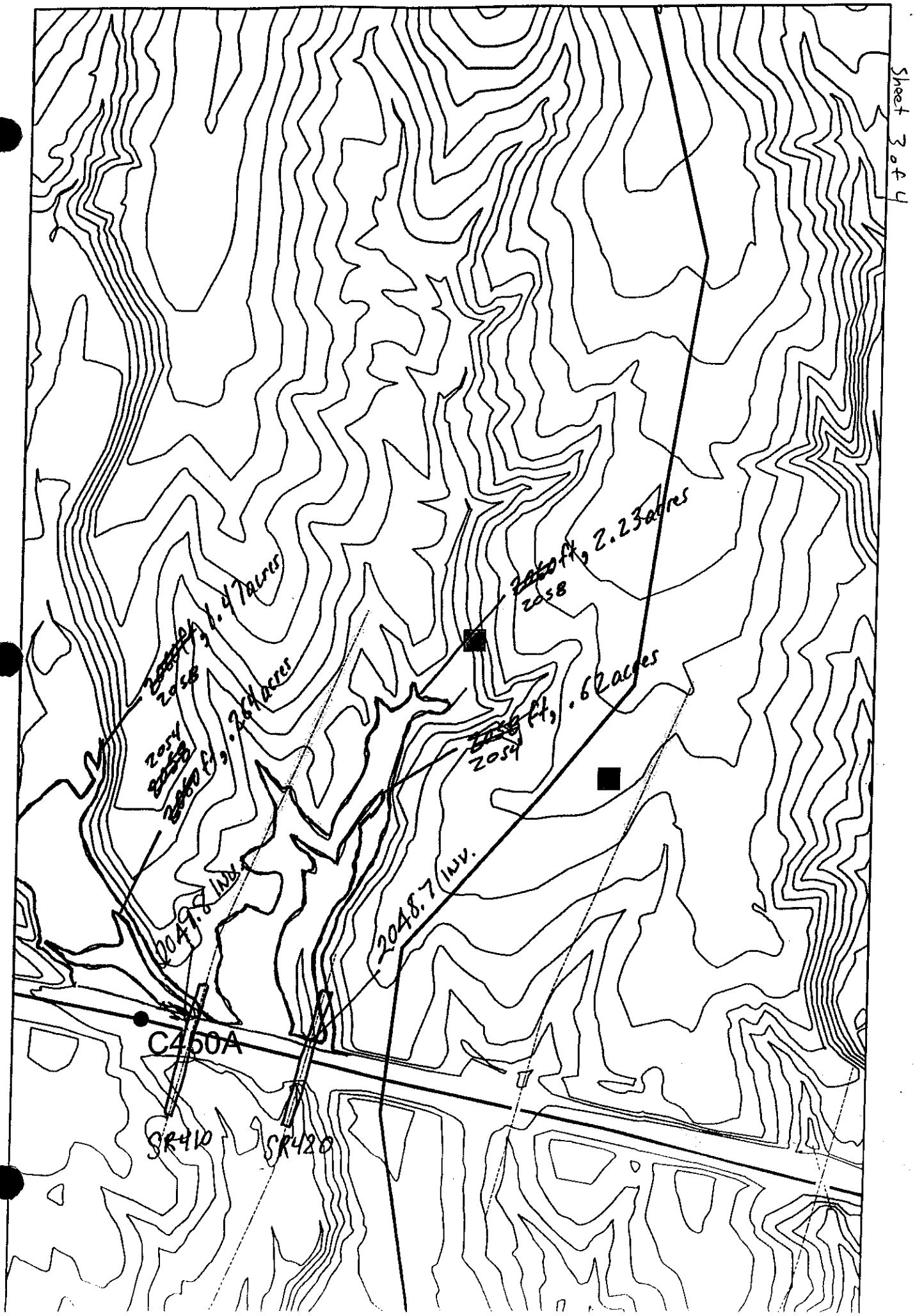
El. inlet face invert 2048.65 ft El. outlet invert 2047.9 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR450

PERFORM CURVE FOR CULVERT 1 - 1(10 (ft) BY 8 (ft)) RCB

DIS- HEAD- INLET OUTLET

Sheet 2 of 4


Sheet 3 of 4
2058 ft, 2.23 acres
2058
2058
2054
2054 ft, .62 acres
2049.8 INV.
2048.7 INV.
C450A
SR410
SR420

Sheet 4 of 4

C450A

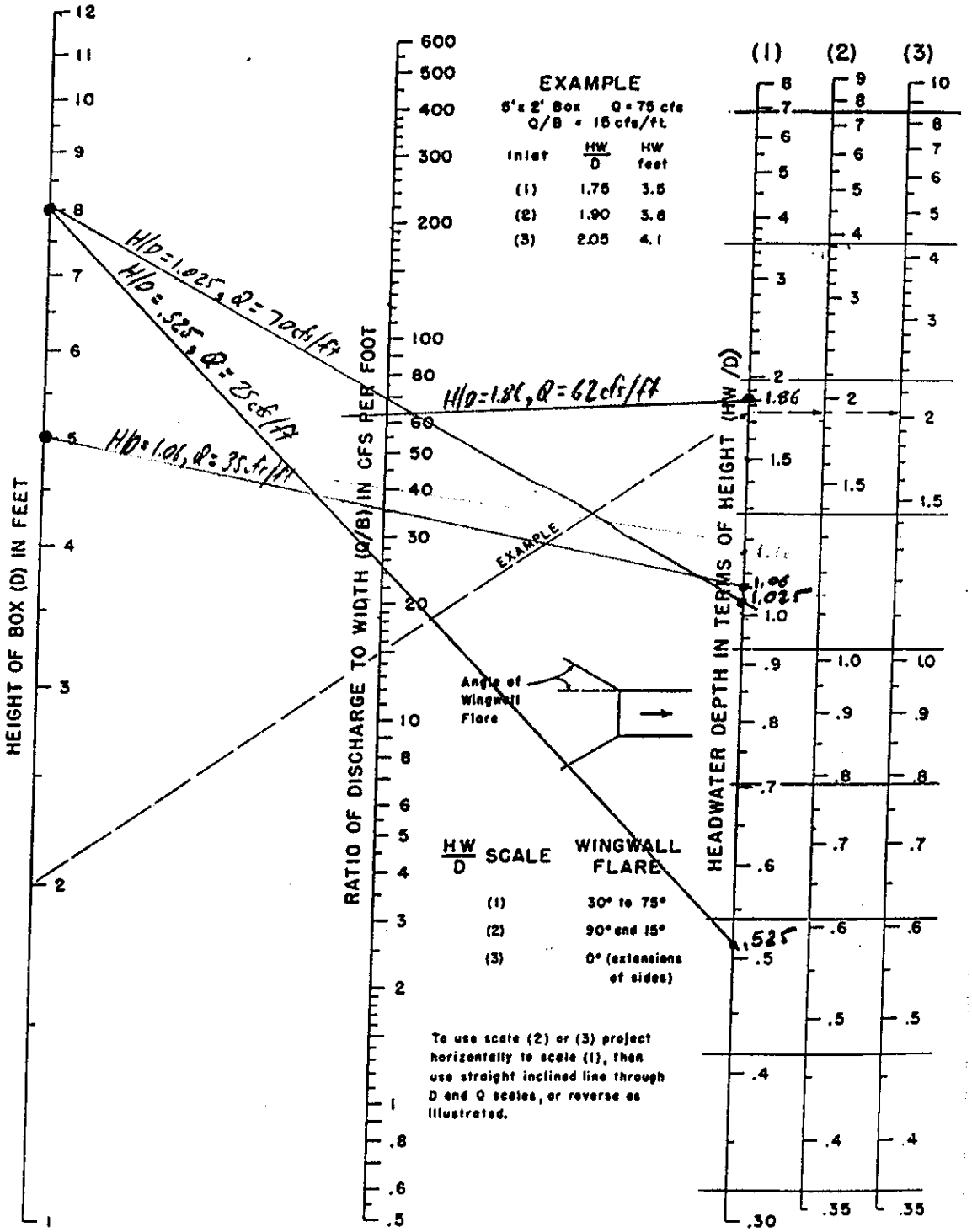


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

Hwy 74 at C452A

Entellus™

SHEET 1 OF 3

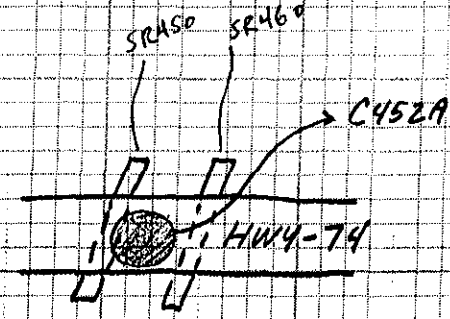
BY DS DATE 4/1/14

CHECK ____ DATE ____

CLIENT FCD

JOB NAME Wittmann AOMSU JOB NO. 310.032

STAGE - STORAGE - DISCHARGE: C452A



Preliminary Q @ C452A = 766 cfs

SR450: 1 - 10' × 8' RBC, invert @ 2032.5 ft

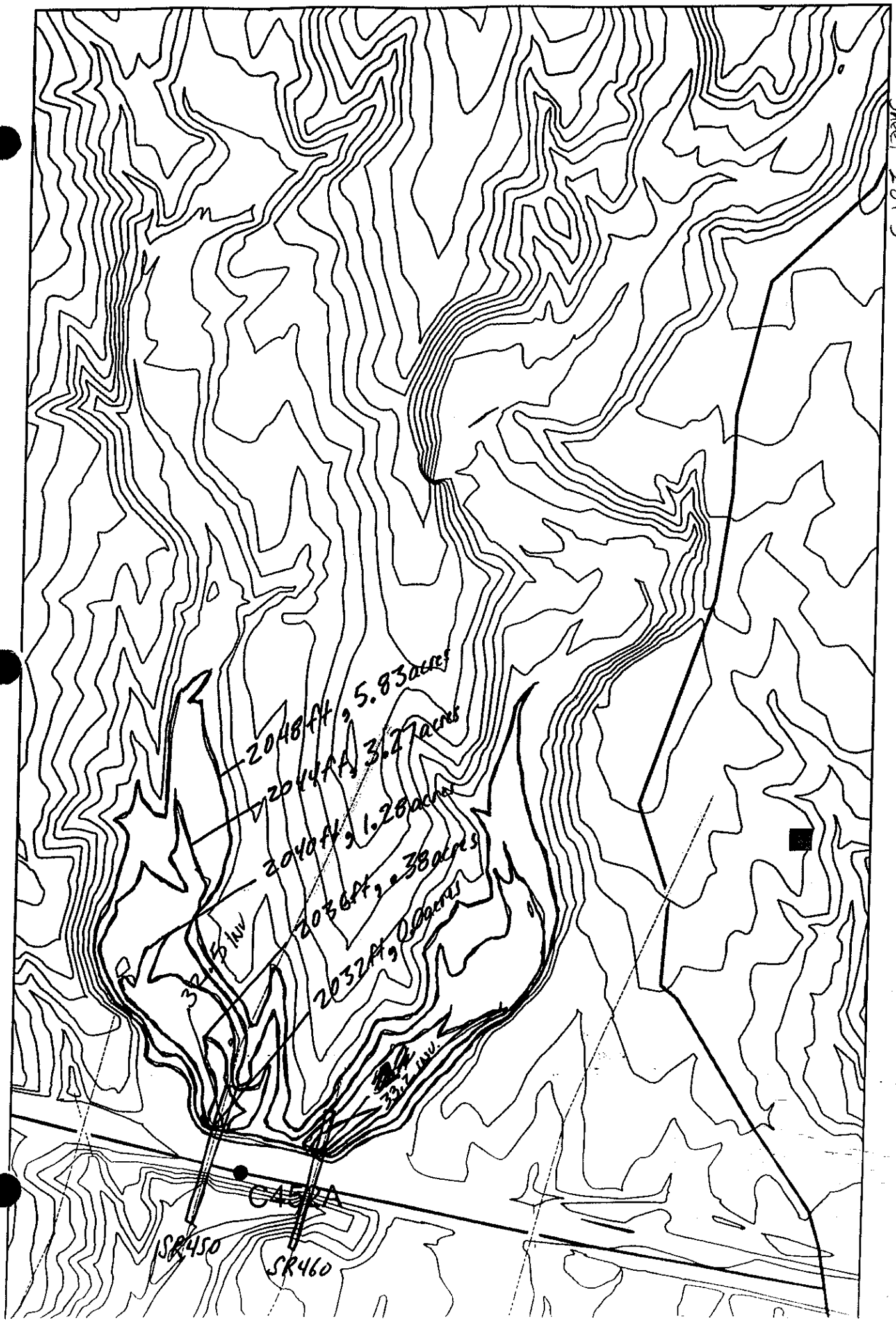
SR460: 1 10' × 8' RBC, invert @ 2033.2 ft

ELEVATION (ft)	STORAGE (acres)	SR450 Q (cfs)	SR460 Q (cfs)	TOTAL Q (cfs)
2032.0	0	0	0	0
2036	.38	190	140	330
2040	1.28	620	500	1120
2044	3.27	1000	850	1850
2048	5.83*	1300	1300	2600

Max HWD = 18-19'
per ADOT Plans

* Max Storage

All discharges were estimated using nomogram.


2048ft, 5.83acres
2044ft, 3.47acres
2040ft, 1.28acres
2036ft, .38acres
2032ft, 0.00acres
SR450
SR460

Sheet 2 of 3

Sheet 3 of 3

C452A

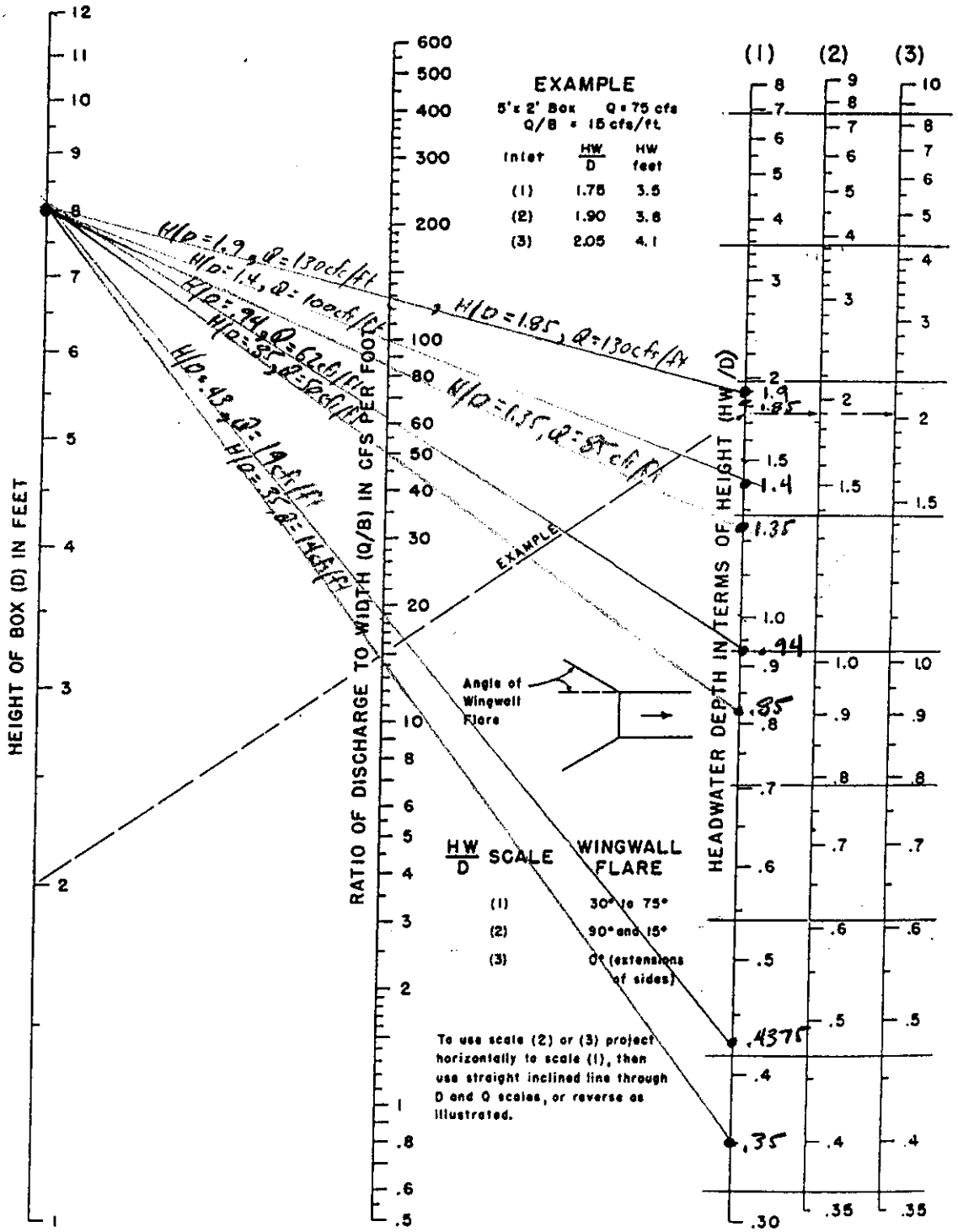


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

Hwy 74 at CTW460

CJL
4/6/4

Sheet 1 of 3

STATE ROUTE 74-CULVERT ANALYSIS

36	2038.69	1.59	1.59	1-S2n	0.98	1.04	0.98	0.88	6.12	3.48
54	2039.18	2.08	2.08	1-S2n	1.28	1.36	1.16	1.11	7.74	3.98
72	2039.63	2.53	2.53	1-S2n	1.57	1.65	1.45	1.31	8.27	4.36
90	2040.04	2.94	2.94	1-S2n	1.84	1.92	1.72	1.48	8.74	4.68
108	2040.43	3.33	3.33	1-S2n	2.1	2.16	2.09	1.64	8.6	4.95
126	2040.79	3.69	3.69	1-S2n	2.34	2.4	2.3	1.79	9.14	5.18
144	2041.14	4.04	4.04	1-S2n	2.59	2.62	2.52	1.93	9.52	5.4
162	2041.47	4.37	4.37	1-S2n	2.82	2.84	2.74	2.05	9.87	5.59
180	2042.26	4.71	5.16	2-M2c	3.06	3.04	3.04	2.18	9.86	5.76

AAAA

Sheet 2 of 3

CTW460

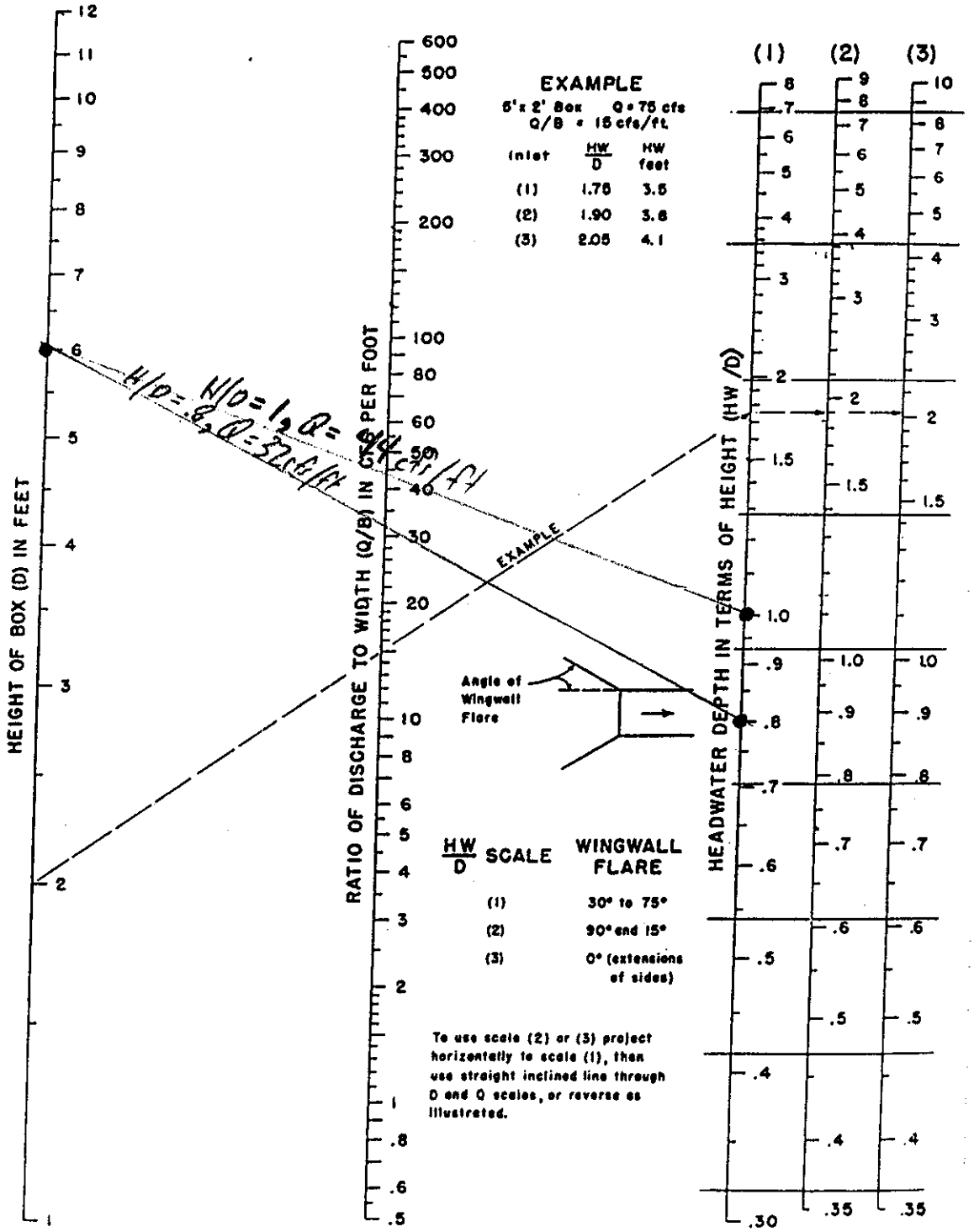
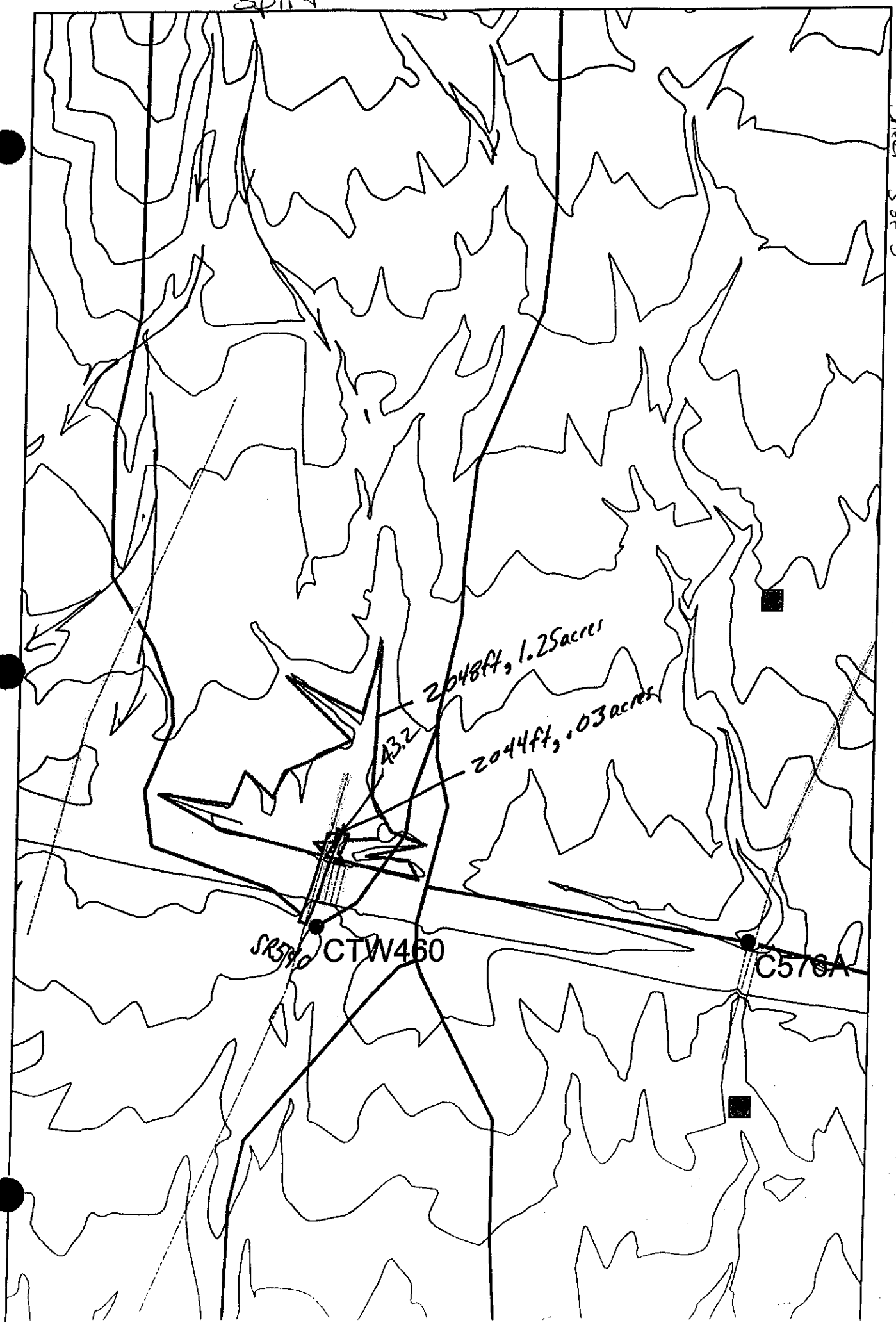


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)


Sheet 3 of 3
2048ft, 1.25acres
43.2
2044ft, .03acres
SR576
CTW460
C576A

Hwy 74 at C580A

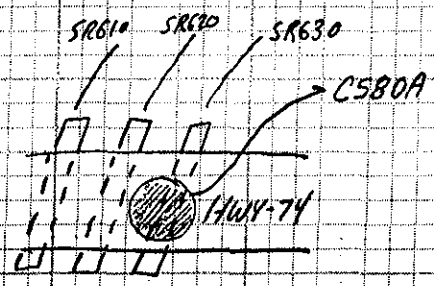
Entellus™

SHEET 1 OF 4
BY JS DATE 8/1/4
CHECK ____ DATE ____

CLIENT FCD

JOB NAME Wittmann QOMSU JOB NO. 310032

STAGE-STORAGE-DISCHARGE : C580A Sta. 330 to 334



Preliminary Q @ C580A = 2992 cfs
1260
1200

SR610: 1-36" RCP Max HWD = 4.5'
SR620: 1-36" RCP Max HWD 4.5'
SR630: 3-10'x5' RCBC, Invert @ 2015.5 ft Max HWD = 9.5'
= 24.0

NOTE: SR610 and SR620 were not modeled because the capacity of SR630 is much greater than theirs.

ELEVATION (ft)	Storage (Acres)	Q (cfs)
2015.5	0	0
2016	.04	84₁
2020	.21	840₂
2024	2.72*	1710₂
2026	2.72	10,000 (overtops)

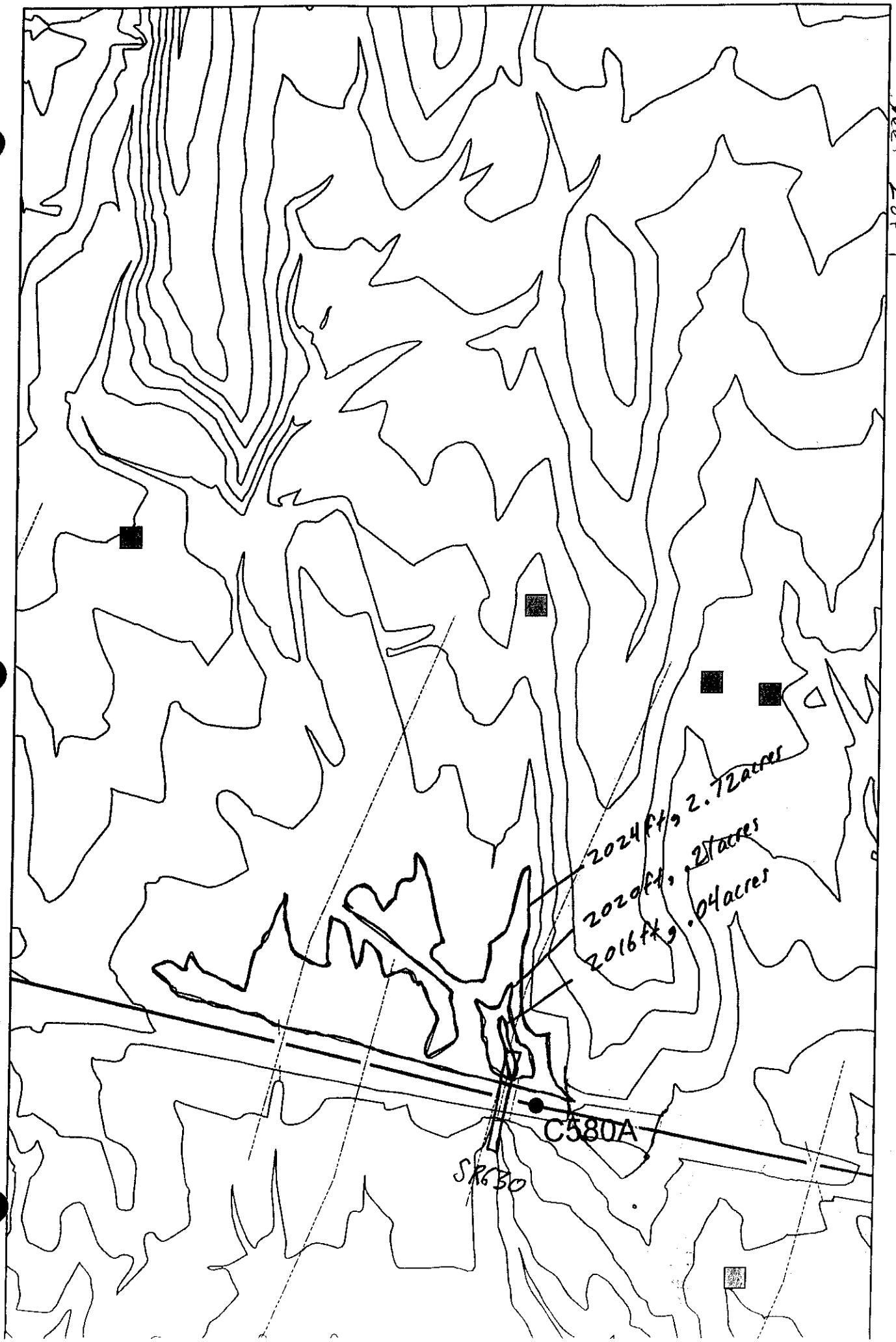
This looks like it will exceed capacity of culverts and Q will be diverted east to SR ~~[illegible]~~ 640 to 690.

~~Divert to east~~, before overtopping road.

1 Estimated using H48
* Max Storage
2 Estimated using nomograms

Picture of culvert outlet is scoured out, like it has had excessive flows thru it.

This diversion is about 30 cfs, which is not significant - ∴ it was not included in the model.


2024ft, 2.72acres
2020ft, .21acres
2016ft, .04acres
C580A
SR630

Sheet 2 of 4

192	2022.6	2.5	2.5	1-S2n	0.93	1.65	1.07	1.58	11.2	6.34	
216	2022.81	2.71	2.71	1-S2n	1.01	1.79	1.17	1.69	11.58	6.59	
240	2023.01	2.91	2.91	1-S2n	1.08	1.92	1.27	1.8	11.85	6.82	

ÄÄ

El. inlet face invert 2020.1 ft El. outlet invert 2019 ft

El. inlet throat invert 0 ft El. inlet crest 0 ft

SR630

PERFORM CURVE FOR CULVERT 1 - 3(10 (ft) BY 5 (ft)) RCB

Concentration Point: C58A

ÄÄ

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2015.5	0	0	0-NF	0	0	0	0	0	0
42	2015.85	0.35	0.35	1-S2n	0.21	0.39	0.19	0.65	7.21	3.04
84	2016.11	0.61	0.61	1-S2n	0.43	0.63	0.46	0.98	6.12	3.9
126	2016.3	0.8	0.8	1-S2n	0.57	0.82	0.52	1.24	8.08	4.51
168	2016.49	0.99	0.99	1-S2n	0.68	0.99	0.72	1.47	7.74	4.98
210	2016.64	1.14	1.14	1-S2n	0.78	1.15	0.84	1.67	8.31	5.37
252	2016.78	1.28	1.28	1-S2n	0.89	1.3	0.96	1.86	8.73	5.71
294	2017.93	1.43	2.43	3-M1t	1	1.44	2.03	2.03	4.82	6.01
336	2018.22	1.57	2.72	3-M1t	1.08	1.58	2.2	2.2	5.1	6.27
378	2018.52	1.69	3.02	3-M1t	1.16	1.71	2.35	2.35	5.36	6.52
420	2018.61	1.81	3.11	3-M1t	1.25	1.83	2.49	2.49	5.61	6.74

ÄÄ

El. inlet face invert 2015.5 ft El. outlet invert 2014.9 ft

El. inlet throat invert 0 ft El. inlet crest 0 ft

SR660

PERFORM CURVE FOR CULVERT 1 - 1(4 (ft) BY 4 (ft)) RCP

ÄÄ

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2011.7	0	0	0-NF	0	0	0	0	0	0
33	2014.05	2.35	2.35	1-S2n	0.95	1.7	0.9	0.71	15.48	4.97
66	2015.23	3.53	3.53	1-S2n	1.37	2.45	1.48	1.05	15.59	6.22
99	2016.38	4.68	4.68	5-S2n	1.72	3	1.88	1.32	17.01	7.06
132	2017.89	6.19	6.19	5-S2n	2.03	3.41	2.26	1.55	18.08	7.7
165	2019.88	8.18	8.18	5-S2n	2.33	3.75	2.61	1.75	19.03	8.22
198	2022.32	10.62	6.99	6-S2n	2.64	4	2.93	1.93	20.11	8.67
231	2025.16	13.46	9.52	6-S2n	2.97	4	3.27	2.09	21.05	9.06
264	2028.44	16.74	12.43	6-S2n	3.42	4	3.9	2.24	21.29	9.41
297	2032.36	20.66	15.74	6-S2n	4	4	3.9	2.39	23.95	9.73
330	2037.48	25.78	19.43	6-S2n	4	4	3.9	2.52	26.61	10.02

Sheet 3 of 4

Sheet 4 of 4

C580A

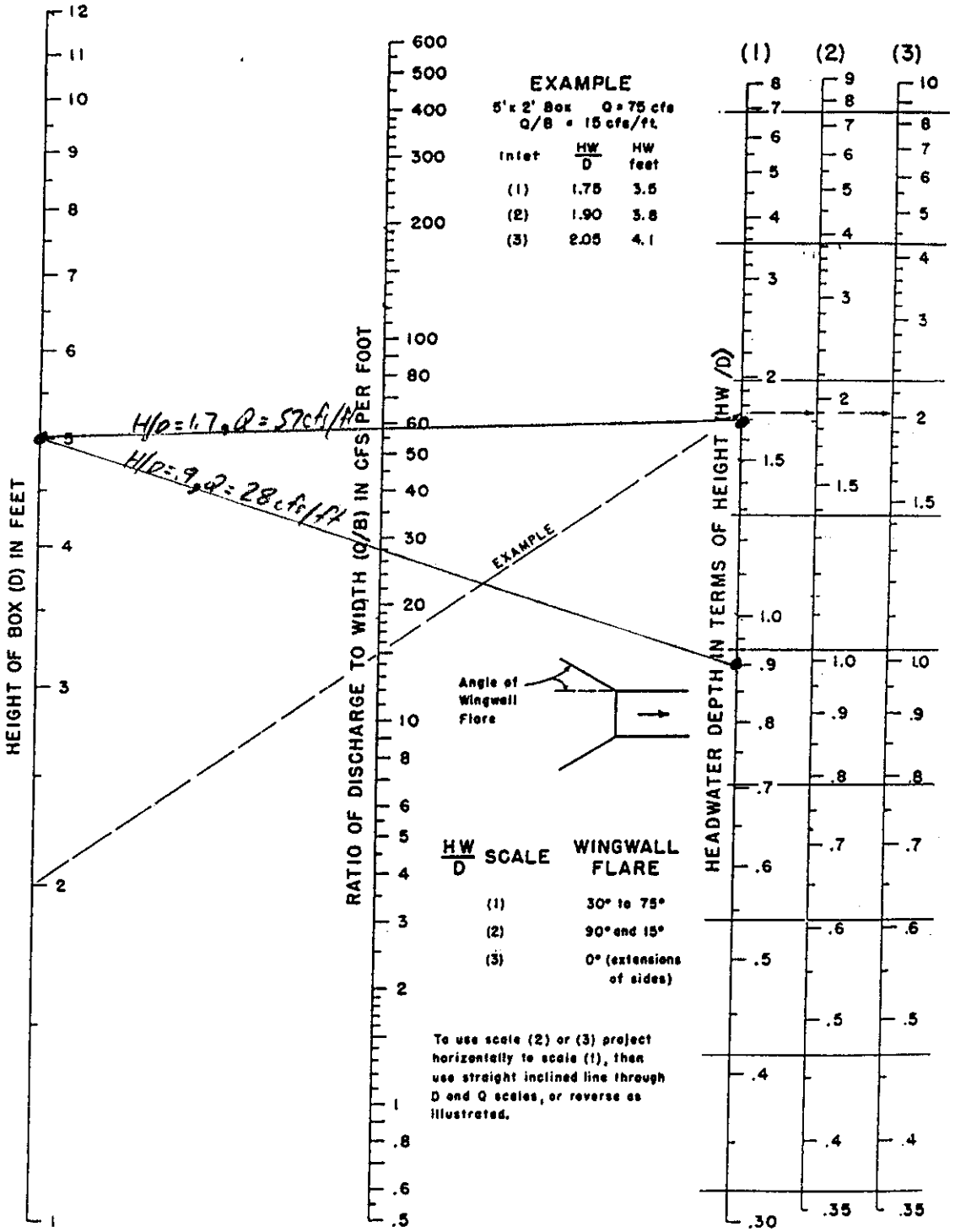


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

Hwy 74 at CWI578

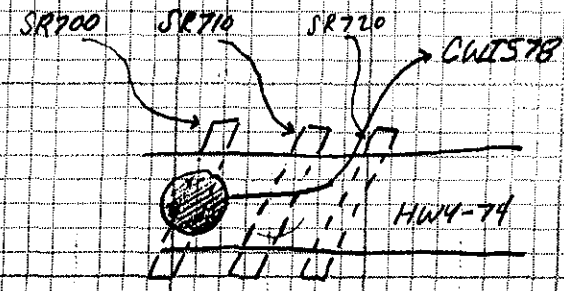
Entellus™

SHEET 1 OF 4
BY JS DATE 4/1/4
CHECK CR DATE 4/6/4

CLIENT FCD

JOB NAME Wittmann Dam SU JOB NO. 310032

STAGE - STORAGE + DISCHARGE : CWIS78



Preliminary Q @ CWIS78 = 559 cfs

SR700: 3-10' x 4' RCB, invert @ 2001.1 Max HWD = 4'
SR710: 30" RCP
SR720: 10" RCP, invert @ 1992.4 ft Max HWD = 12'

Note: SR710 was not modeled because its capacity is much less than that of SR720 and SR700

Elevation (ft)	Storage (acres)	SR 720 Q (cfs)	SR 700 Q (cfs)	Total Q (cfs)
1992.4	0	0	0	0
2004	4.4	340	600	940
2005				
~~2008~~	~~10.59*~~	~~390~~	~~1680~~	~~2070~~
2005	5.9**	350	690	1040

Max HWD per ADOT As Built: = 4.0' above invert at SR700 @ 2005

* Max Storage
1 from HW48
2 from nomograph

** no contour at 2005, so storage area is estimated using linear interpolation

$$\left(\frac{10.59-4.4}{2008-2004}\right)(2005-2004)+4.4 = 5.9 \text{ acres}$$

Sheet 2 of 4

CW1578

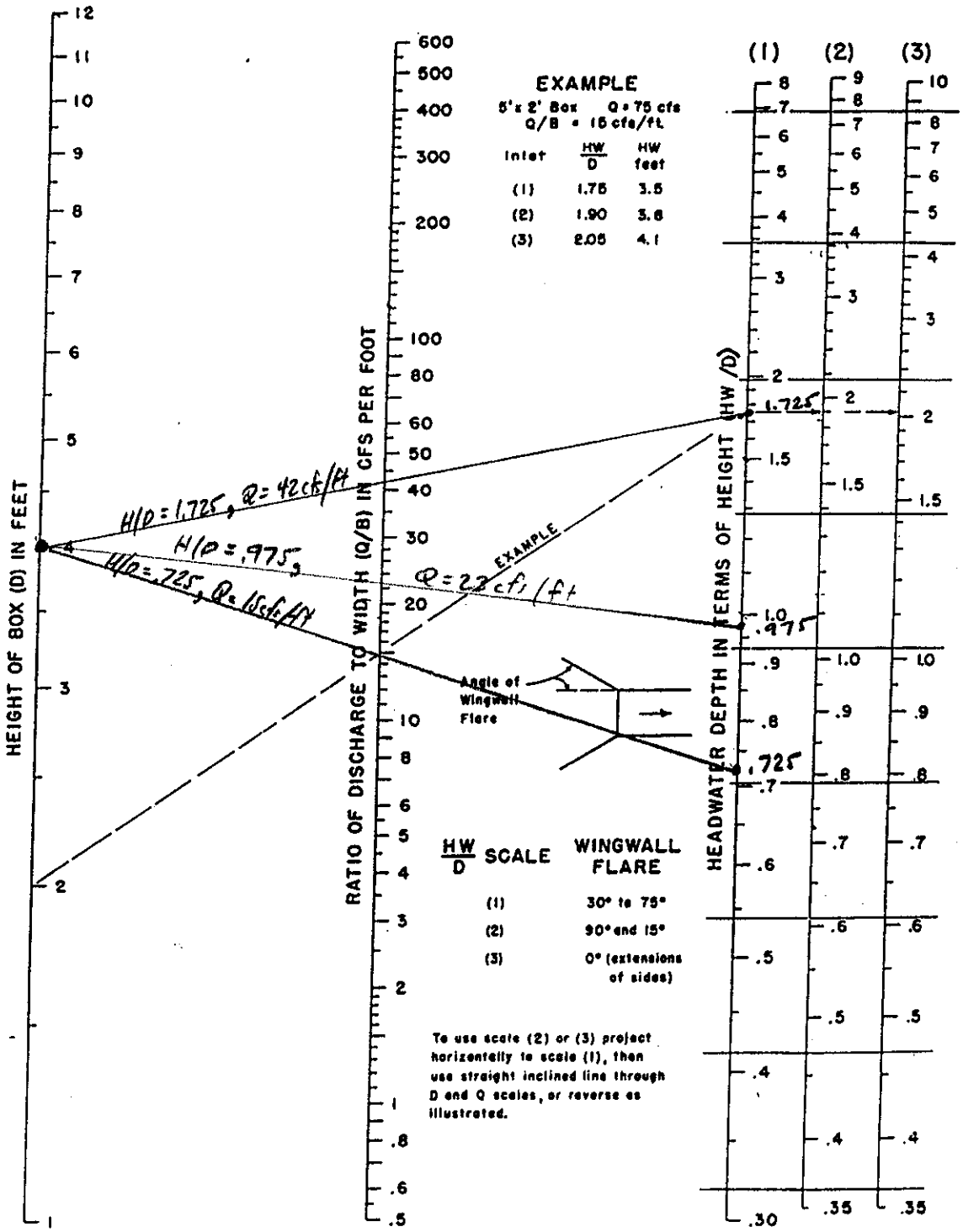
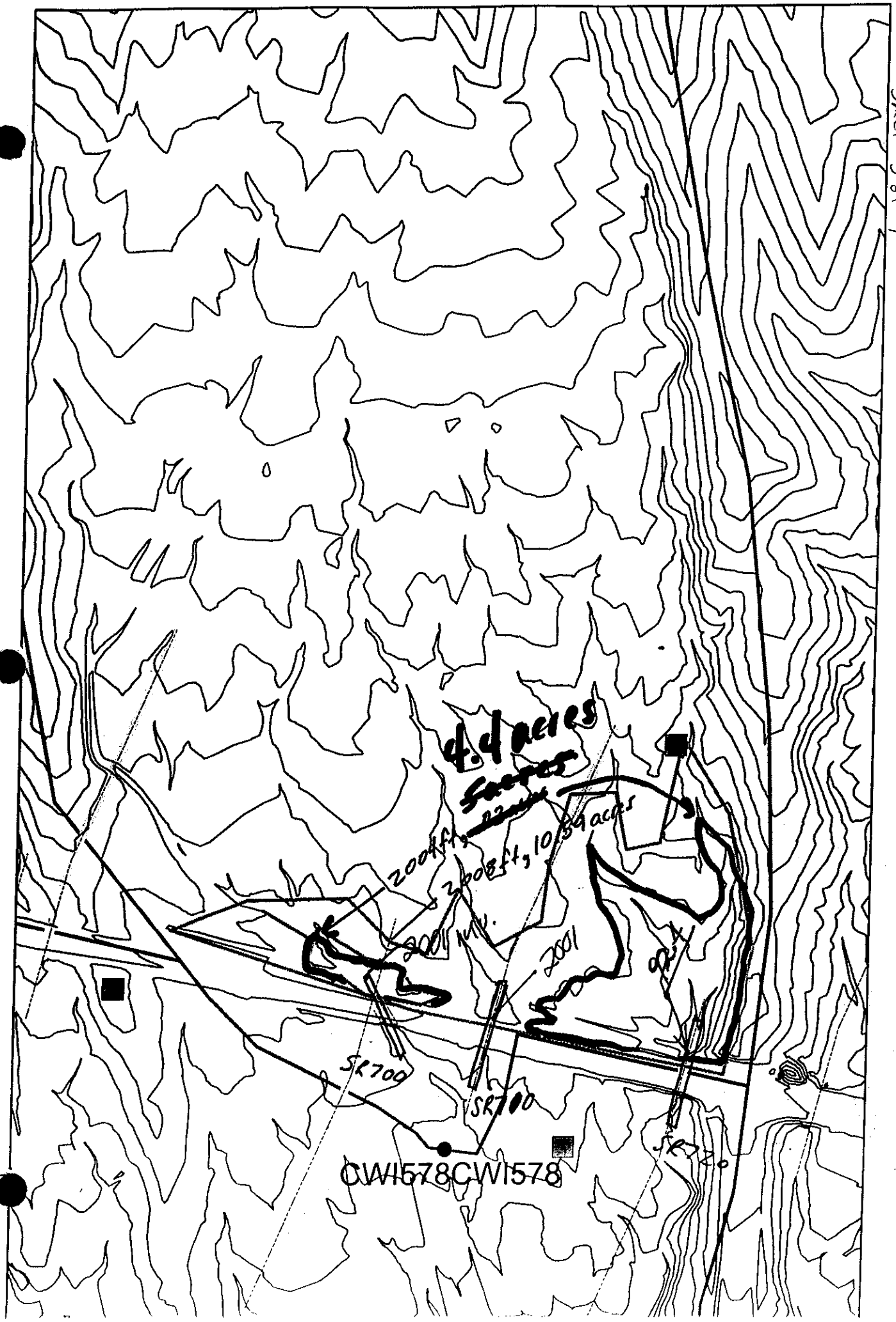


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)


4.4 acres
200 ft
2008 ft, 10.59 acres
2001 MW
2001
SR700
SR700
SR700
CWI578CWI578

SR720

PERFORM CURVE FOR CULVERT 1 - 1(5 (ft) BY 5 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1992.4	0	0	0-NF	0	0	0	0	0	0
60	1995.45	3.05	3.05	1-S2n	1.5	2.17	1.61	1.12	10.98	4.38
120	1996.96	4.56	4.56	1-S2n	2.16	3.12	2.39	1.66	12.93	5.44
180	1998.49	6.09	6.09	5-S2n	2.75	3.83	3.07	2.07	14.25	6.15
240	2000.54	8.14	8.14	5-S2n	3.33	4.33	3.67	2.42	15.58	6.69
300	2003.24	10.84	10.84	5-S2n	4	4.78	4.24	2.72	16.97	7.13
360	2006.54	14.14	11.72	6-S2n	5	5	4.9	3	18.53	7.5
420	2010.37	17.97	14.57	6-S2n	5	5	4.9	3.25	21.62	7.83
480	2014.85	22.45	17.87	6-S2n	5	5	4.9	3.48	24.7	8.13
540	2020.39	27.99	21.61	6-S2n	5	5	4.9	3.7	27.79	8.39
600	2027.96	35.56	25.79	6-S2n	5	5	4.9	3.9	30.88	8.64

El.	inlet	face	invert	1992.4 ft	El.	outlet	invert	1991.2 ft
El.	inlet	throat	invert	0 ft	El.	inlet	crest	0 ft

SR730

PERFORM CURVE FOR CULVERT 1 - 1(4 (ft) BY 4 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1991.2	0	0	0-NF	0	0	0	0	0	0
37	1993.75	2.55	2.55	1-S2n	1.27	1.8	1.33	0.95	10.07	3.91
74	1995.02	3.82	3.82	1-S2n	1.86	2.59	1.99	1.41	11.82	4.85
111	1996.41	5.21	5.21	5-S2n	2.38	3.18	2.56	1.76	13.08	5.47
148	1998.32	7.12	7.12	5-S2n	2.94	3.57	3.1	2.05	14.17	5.95
185	2000.84	9.64	8.3	2-M2c	4	3.96	3.96	2.31	14.8	6.34
222	2003.88	12.68	10.72	6-S2n	4	4	3.9	2.54	17.9	6.67
259	2007.44	16.24	13.58	6-S2n	4	4	3.9	2.75	20.88	6.96
296	2011.76	20.56	16.88	6-S2n	4	4	3.9	2.95	23.87	7.22
333	2017.56	26.36	20.62	6-S2n	4	4	3.9	3.13	26.85	7.46
370	2026.24	35.04	24.8	6-S2n	4	4	3.9	3.3	29.83	7.67

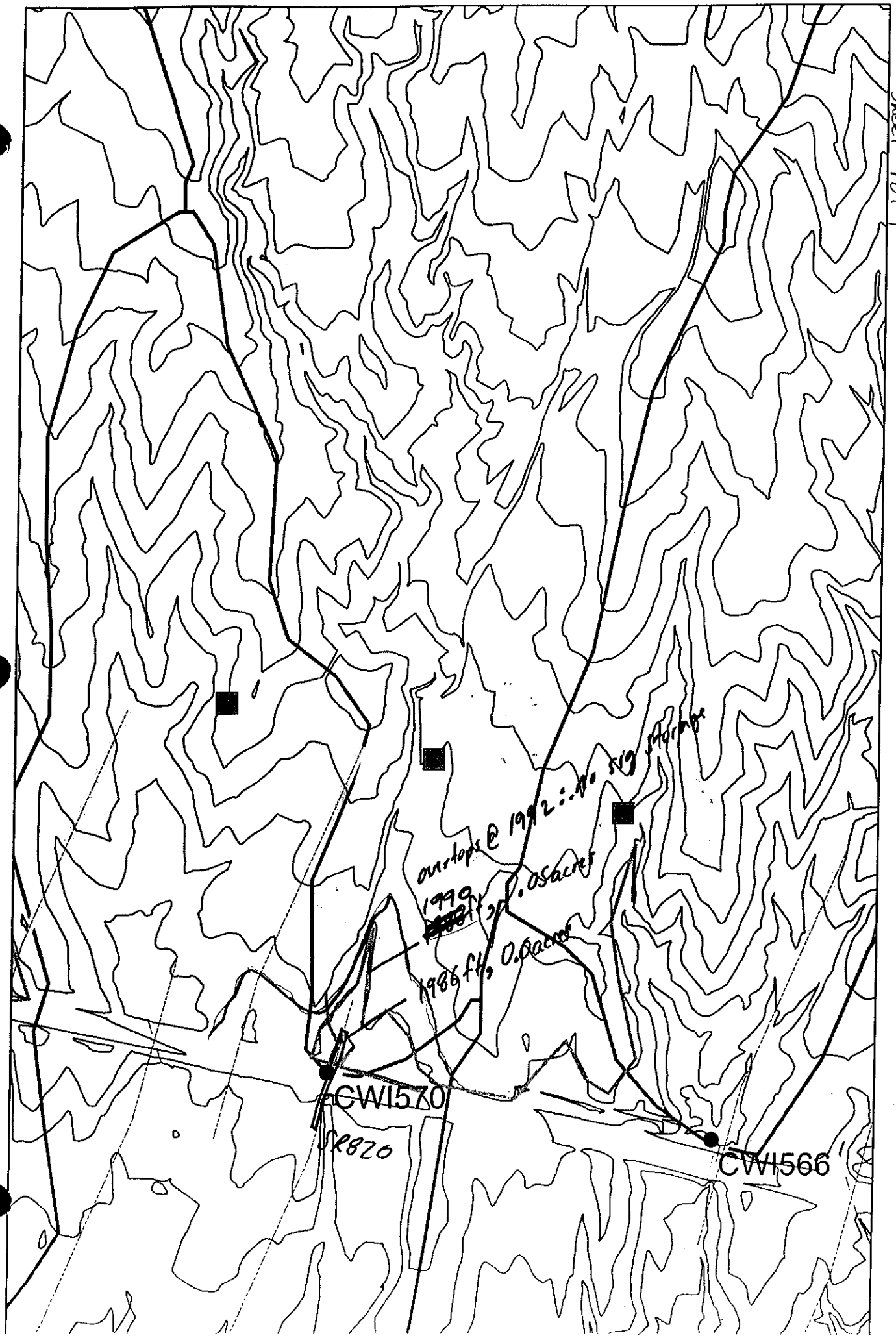
El.	inlet	face	invert	1991.2 ft	El.	outlet	invert	1990 ft
El.	inlet	throat	invert	0 ft	El.	inlet	crest	0 ft

SR740

PERFORM CURVE FOR CULVERT 1 - 2(8 (ft) BY 4 (ft)) RCB

Sheet 4 of 4

Hwy 74 at CWI570


Sheet 1 of 1
overlaps @ 1992 : No sig storage
1990 ~~[illegible]~~ 3 ft, 0.05 acres
1986 ft, 0.00 acres
CWI570
SR820
CWI566

Hwy 74 at CWI566

116	1994.14	5.44	5.44	5-S2n	2.9	3.24	2.96	1.89	11.66	5.2
145	1995.65	6.95	6.35	2-M2c	4	3.54	3.54	2.13	12.34	5.54
174	1997.54	8.84	8.09	2-M2c	4	3.84	3.84	2.35	14.13	5.84
203	1999.76	11.06	9.92	6-S2n	4	4	3.9	2.54	16.37	6.09
232	2002.29	13.59	11.98	6-S2n	4	4	3.9	2.73	18.71	6.32
261	2005.16	16.46	14.32	6-S2n	4	4	3.9	2.9	21.04	6.53
290	2008.49	19.79	16.92	6-S2n	4	4	3.9	3.06	23.38	6.72

El. inlet face invert 1988.7 ft El. outlet invert 1987.9 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR820

PERFORM CURVE FOR CULVERT 1 - 2(8 (ft) BY 4 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1986.4	0	0	0-NF	0	0	0	0	0	0
11	1986.79	0.39	0.39	1-S2n	0.07	0.25	0.05	0.25	15.15	2.69
22	1986.98	0.58	0.58	1-S2n	0.13	0.39	0.09	0.38	15.36	3.5
33	1987.16	0.76	0.76	1-S2n	0.2	0.51	0.25	0.48	8.24	4.07
44	1987.32	0.92	0.92	1-S2n	0.27	0.62	0.22	0.57	12.6	4.53
55	1987.47	1.07	1.07	1-S2n	0.33	0.72	0.36	0.65	9.43	4.92
66	1987.61	1.21	1.21	1-S2n	0.4	0.81	0.31	0.72	13.3	5.25
77	1987.74	1.34	1.34	1-S2n	0.43	0.9	0.46	0.79	10.51	5.55
88	1987.87	1.47	1.47	1-S2n	0.47	0.98	0.5	0.85	10.97	5.82
99	1987.99	1.59	1.59	1-S2n	0.5	1.06	0.55	0.91	11.32	6.07
110	1988.1	1.7	1.7	1-S2n	0.53	1.14	0.59	0.97	11.67	6.3

El. inlet face invert 1986.4 ft El. outlet invert 1984.3 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

Concentration Point: CWI570

SR830

PERFORM CURVE FOR CULVERT 1 - 2(10 (ft) BY 6 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1977.2	0	0	0-NF	0	0	0	0	0	0
13	1977.66	0.46	0.46	1-S2n	0.07	0.24	0.04	0.31	17.87	2.06
26	1977.81	0.61	0.61	1-S2n	0.15	0.38	0.18	0.46	7.42	2.68
39	1977.96	0.76	0.76	1-S2n	0.22	0.49	0.29	0.59	6.69	3.13
52	1978.1	0.9	0.9	1-S2n	0.29	0.6	0.3	0.7	8.8	3.48
65	1978.25	1.05	1.05	1-S2n	0.37	0.69	0.45	0.8	7.24	3.77
78	1978.39	1.19	1.19	1-S2n	0.44	0.78	0.51	0.89	7.69	4.03

Concentration Point: CWI566
Preliminary Q = 372 cfs

Elevation (ft)	Storage (acres)	Q (cfs)
1977.2	0	0
1980	.36	300
1982	1.82*	640

Sheet 1 of 3

* Max. Storage
Estimated using

Sheet 2 of 3

CW1566

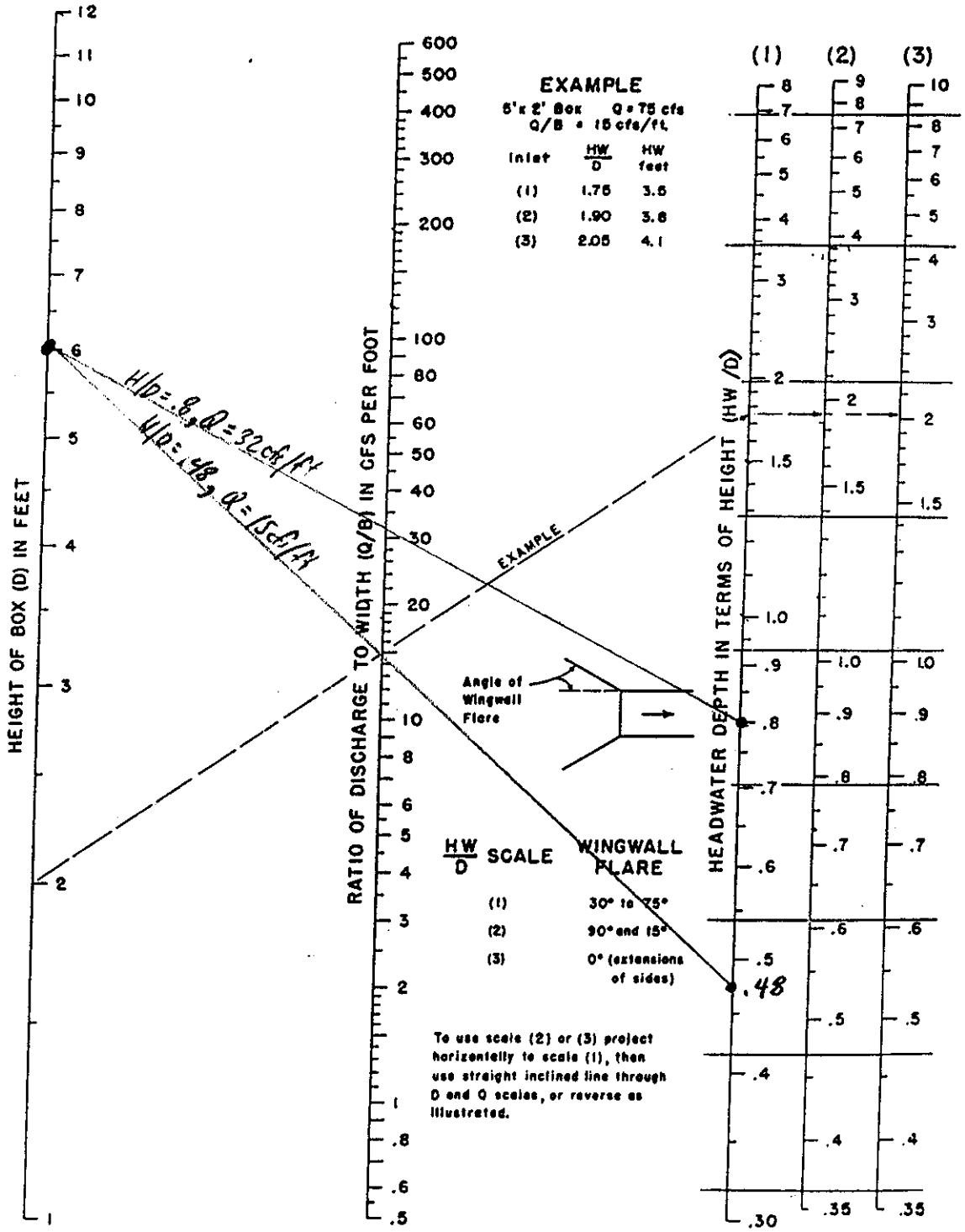
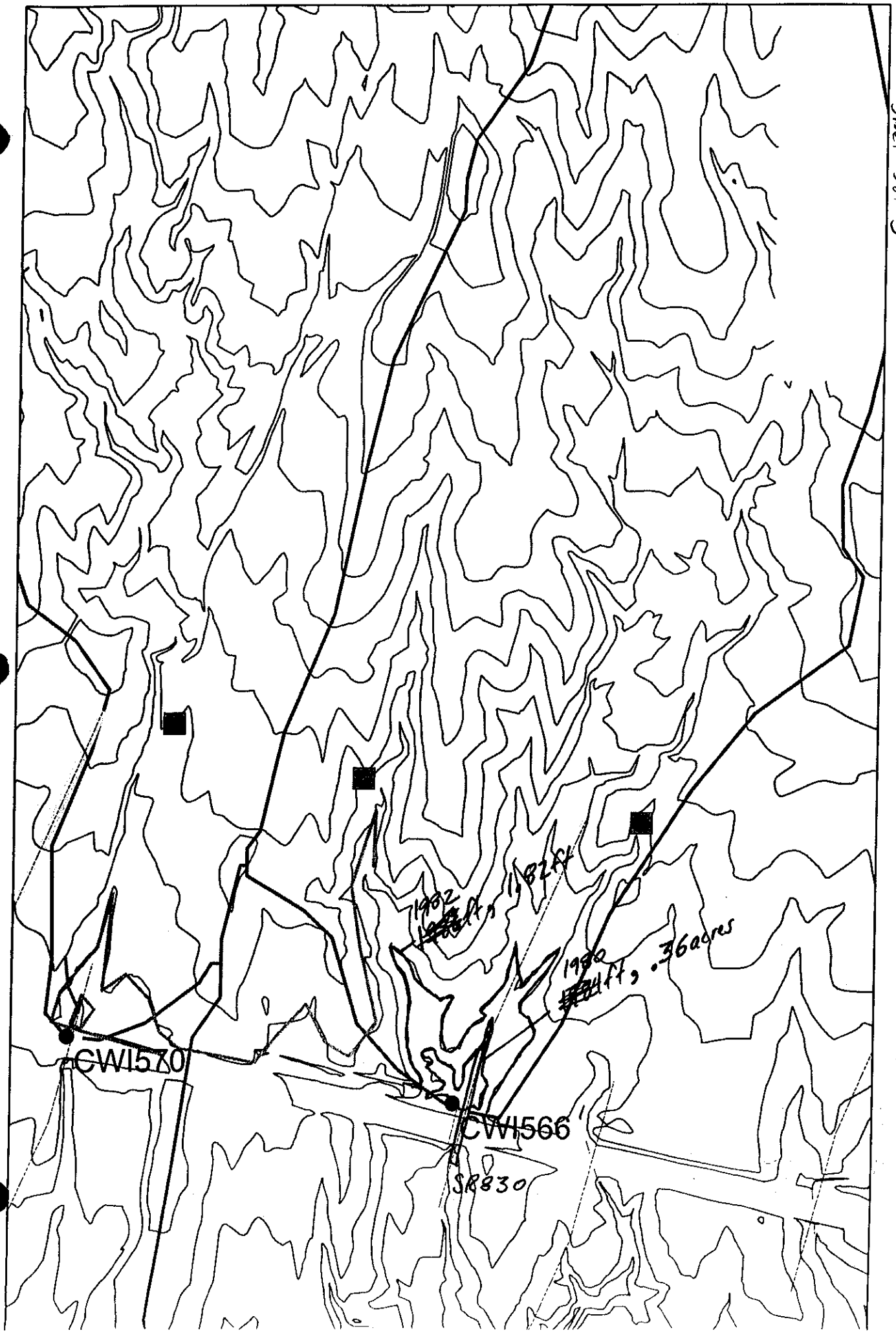


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)


Sheet 3 of 3
1992
1,824
1990
.36acres
CWI570
CWI566
SR830

Hwy 74 at CWI564

91	1978.51	1.31	1.31	1-S2n	0.52	0.86	0.46	0.97	9.79	4.26
104	1978.64	1.44	1.44	1-S2n	0.59	0.95	0.62	1.05	8.45	4.47
117	1978.75	1.55	1.55	1-S2n	0.63	1.02	0.67	1.13	8.75	4.66
130	1978.86	1.67	1.67	1-S2n	0.67	1.1	0.72	1.2	9.06	4.84

El. inlet face invert 1977.2 ft El. outlet invert 1976.2 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR870

PERFORM CURVE FOR CULVERT 1 - 1(3.5 (ft) BY 3.5 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1968.2	0	0	0-NF	0	0	0	0	0	0
28	1970.44	2.24	2.24	1-S2n	0.81	1.62	0.85	0.6	15.36	5.68
56	1971.61	3.41	3.41	1-S2n	1.17	2.34	1.26	0.9	17.98	7.12
84	1972.95	4.75	4.75	5-S2n	1.47	2.85	1.61	1.12	19.49	8.08
112	1974.83	6.63	6.63	5-S2n	1.73	3.2	1.93	1.32	20.57	8.82
140	1977.29	9.09	3.59	6-S2n	1.98	3.5	2.23	1.49	21.67	9.42
168	1980.24	12.04	6.36	6-S2n	2.24	3.5	2.5	1.64	22.87	9.94
196	1983.75	15.55	9.64	6-S2n	2.51	3.5	2.79	1.79	23.84	10.39
224	1988.22	20.02	13.41	6-S2n	2.83	3.5	3.26	1.92	24.14	10.79
252	1994.67	26.47	17.69	6-S2n	3.5	3.5	3.4	2.04	26.59	11.15
280	2004.93	36.73	22.48	6-S2n	3.5	3.5	3.4	2.16	29.54	11.49

El. inlet face invert 1968.2 ft El. outlet invert 1962 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR880

PERFORM CURVE FOR CULVERT 1 - 3(10 (ft) BY 5 (ft)) RCB

Overtopping elev and max storage elev. is 12.85' above invert per ADOT Bridge Hs.

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1960.1	0	0	0-NF	0	0	0	0	0	0
48	1960.5	0.4	0.4	1-S2n	0.21	0.43	0.23	0.69	6.93	3.24
96	1960.76	0.66	0.66	1-S2n	0.43	0.68	0.38	1.05	8.33	4.16
144	1960.98	0.88	0.88	1-S2n	0.57	0.9	0.5	1.33	9.67	4.8
192	1961.17	1.07	1.07	1-S2n	0.68	1.09	0.73	1.57	8.73	5.3
240	1961.34	1.24	1.24	1-S2n	0.78	1.26	0.85	1.78	9.41	5.71
288	1961.51	1.41	1.41	1-S2n	0.89	1.42	0.97	1.98	9.87	6.06
336	1961.67	1.57	1.57	1-S2n	1	1.58	1.09	2.17	10.31	6.38
384	1961.81	1.71	1.71	1-S2n	1.08	1.72	1.19	2.34	10.72	6.66
432	1961.95	1.85	1.85	1-S2n	1.16	1.86	1.3	2.5	11.04	6.91

Concentration Point: CWI564
Preliminary Flow = 739 cfs

Elevation (ft)	Storage (acres)	Q (cfs)
1960.1	0	0
1964	.53	360
1968	2.04*	1950
~~1970~~	~~2.04~~	~~10,000 cfs~~ overtops)
1972*	4.6*	2340

*Max Storage
1 Estimated using nomograph

Sheet 1 of 3

Sheet 2 of 3.

CWI564

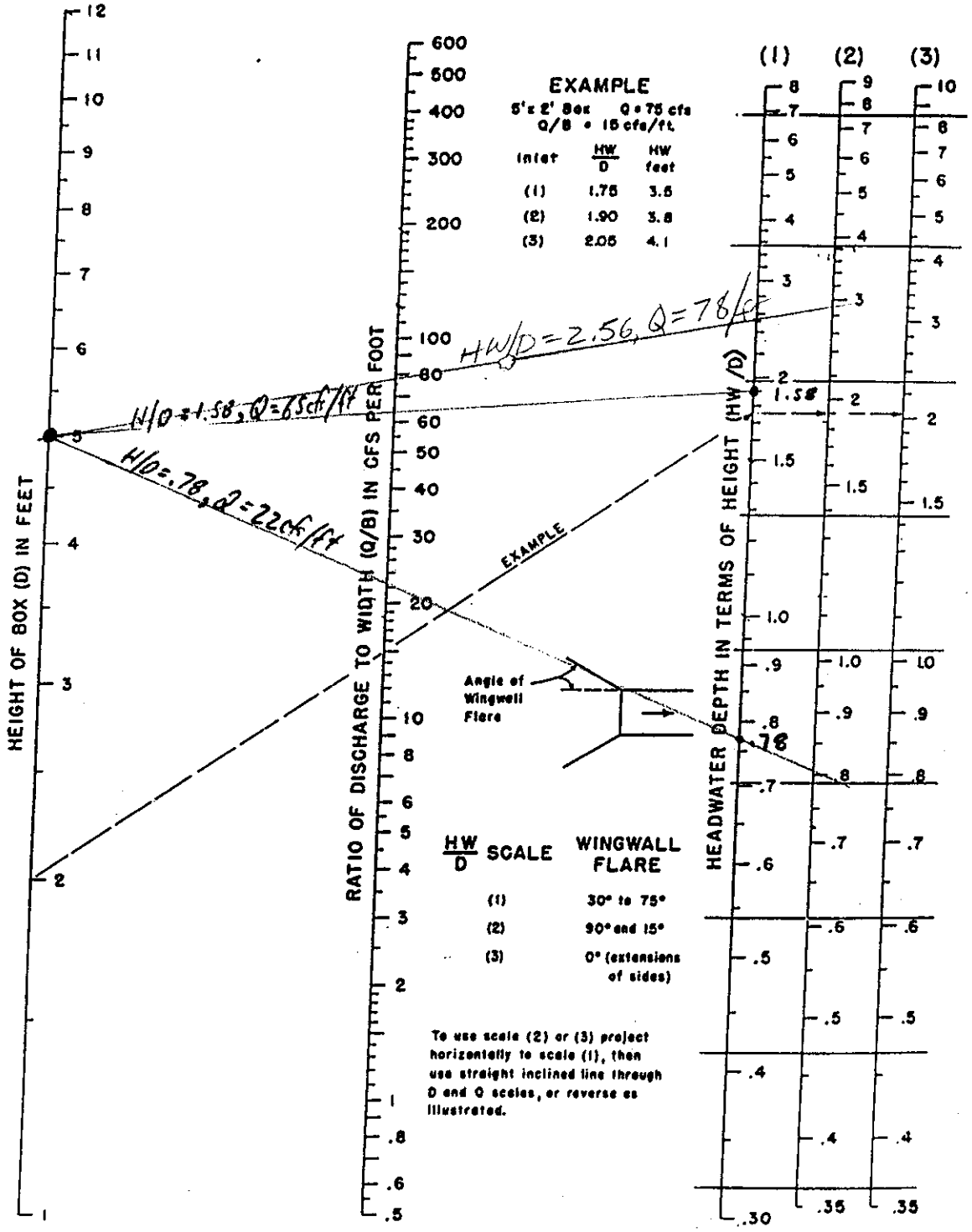
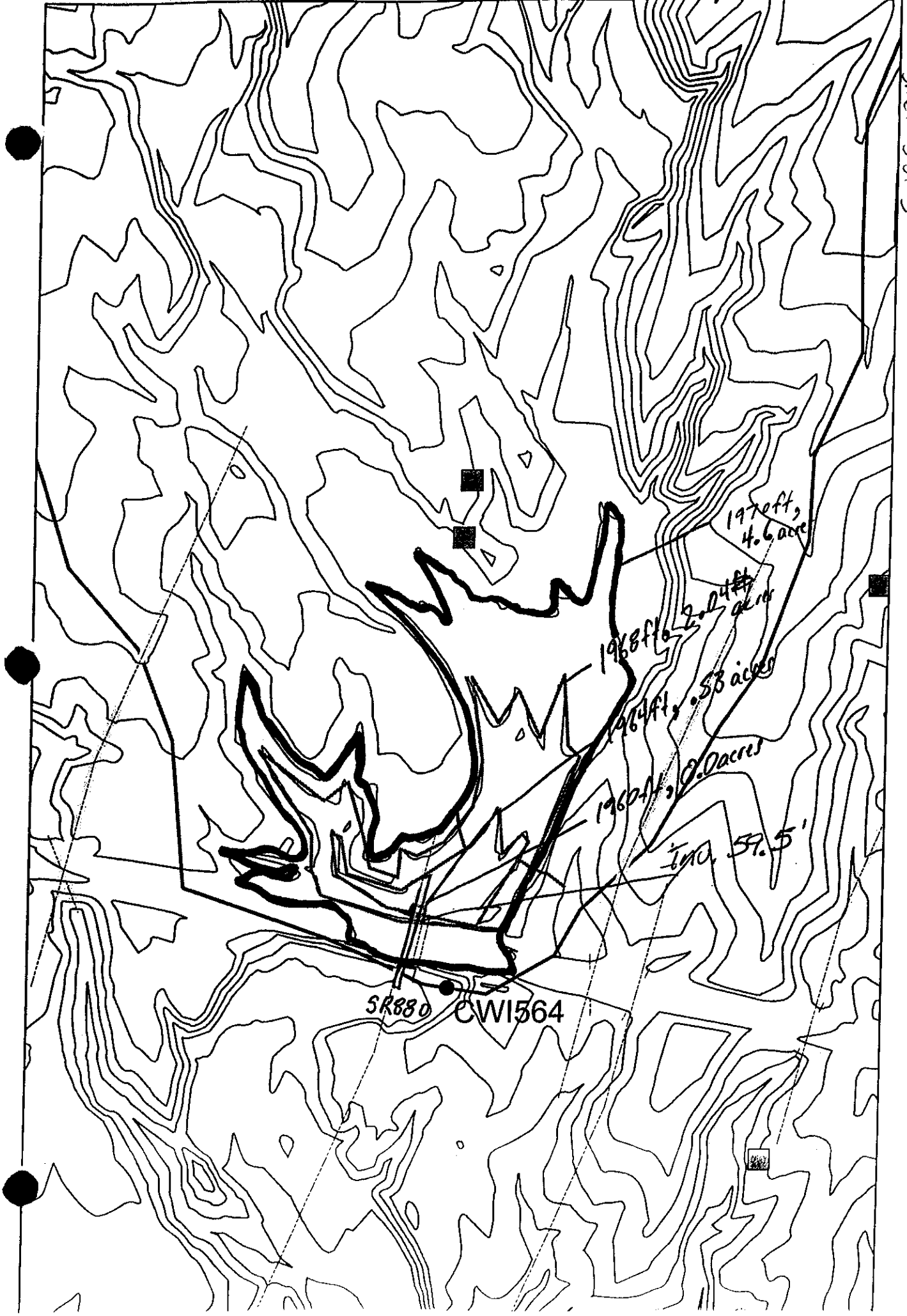


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)


1970ft, 4.6 acre
1968ft, 2.04 acres
1964ft, .58 acres
1960ft, 0.0 acres
Ind. 59.5'
SR880
CWI564

Hwy 74 at CWI540

SR940

El. inlet throat invert 0 ft El. inlet crest 0 ft

PERFORM CURVE FOR CULVERT 3 - 1(10 (ft) BY 5 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1973.75	0	0	0-NF	0	0	0	0	0	0
13	1974.37	0.32	0.62	2-M2c	0.61	0.38	0.38	0.32	3.46	1.95
26	1974.71	0.58	0.96	2-M2c	0.97	0.6	0.6	0.49	4.37	2.54
39	1974.99	0.76	1.24	2-M2c	1.26	0.78	0.78	0.62	5	2.95
52	1975.24	0.93	1.49	2-M2c	1.53	0.95	0.95	0.74	5.5	3.28
65	1975.47	1.08	1.72	2-M2c	1.78	1.1	1.1	0.84	5.92	3.56
78	1975.65	1.22	1.9	2-M2c	2.02	1.24	1.24	0.94	6.3	3.8
91	1975.89	1.36	2.14	2-M2c	2.23	1.37	1.37	1.03	6.63	4.02
104	1976.08	1.49	2.33	2-M2c	2.45	1.5	1.5	1.11	6.93	4.21
117	1976.26	1.61	2.51	2-M2c	2.66	1.62	1.62	1.19	7.21	4.39
130	1976.45	1.73	2.7	2-M2c	2.86	1.74	1.74	1.27	7.46	4.56

El. inlet face invert 1973.75 ft El. outlet invert 1973.7 ft

El. inlet throat invert 0 ft El. inlet crest 0 ft

SR950

PERFORM CURVE FOR CULVERT 1 - 1(4 (ft) BY 4 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1978.8	0	0	0-NF	0	0	0	0	0	0
31	1981.04	2.24	2.24	1-S2n	0.87	1.65	0.92	0.63	14.12	5.31
62	1982.18	3.38	3.38	1-S2n	1.24	2.37	1.37	0.94	16.21	6.68
93	1983.23	4.43	4.43	5-S2n	1.54	2.91	1.77	1.18	17.27	7.59
124	1984.56	5.76	5.76	5-S2n	1.81	3.32	2.12	1.39	18.31	8.29
155	1986.31	7.51	7.51	5-S2n	2.06	3.65	2.44	1.57	19.34	8.86
186	1988.46	9.66	9.66	5-S2n	2.31	3.97	2.73	1.73	20.38	9.35
217	1990.99	12.19	7.87	6-S2n	2.56	4	3	1.88	21.51	9.78
248	1993.87	15.07	10.19	6-S2n	2.82	4	3.27	2.02	22.6	10.17
279	1997.2	18.4	12.81	6-S2n	3.12	4	3.56	2.16	23.65	10.52
310	2001.28	22.48	15.75	6-S2n	3.55	4	3.9	2.28	24.99	10.84

El. inlet face invert 1978.8 ft El. outlet invert 1975.1 ft

El. inlet throat invert 0 ft El. inlet crest 0 ft

SR960

PERFORM CURVE FOR CULVERT 1 - 1(4 (ft) BY 4 (ft)) RCP

Concentration Point: CWIS40 460+ 20

Preliminary Q = 750 cfs

Elevation (ft)	Storage (acres)	Q (cfs)
1974.75	0	78
1976	.08	300
1980	.79*	1350
1983.1	1.34**	1680

* Max Storage

1 Estimated using nomograph

Max HWD = 9.4' above INV. per ADOT AB's.

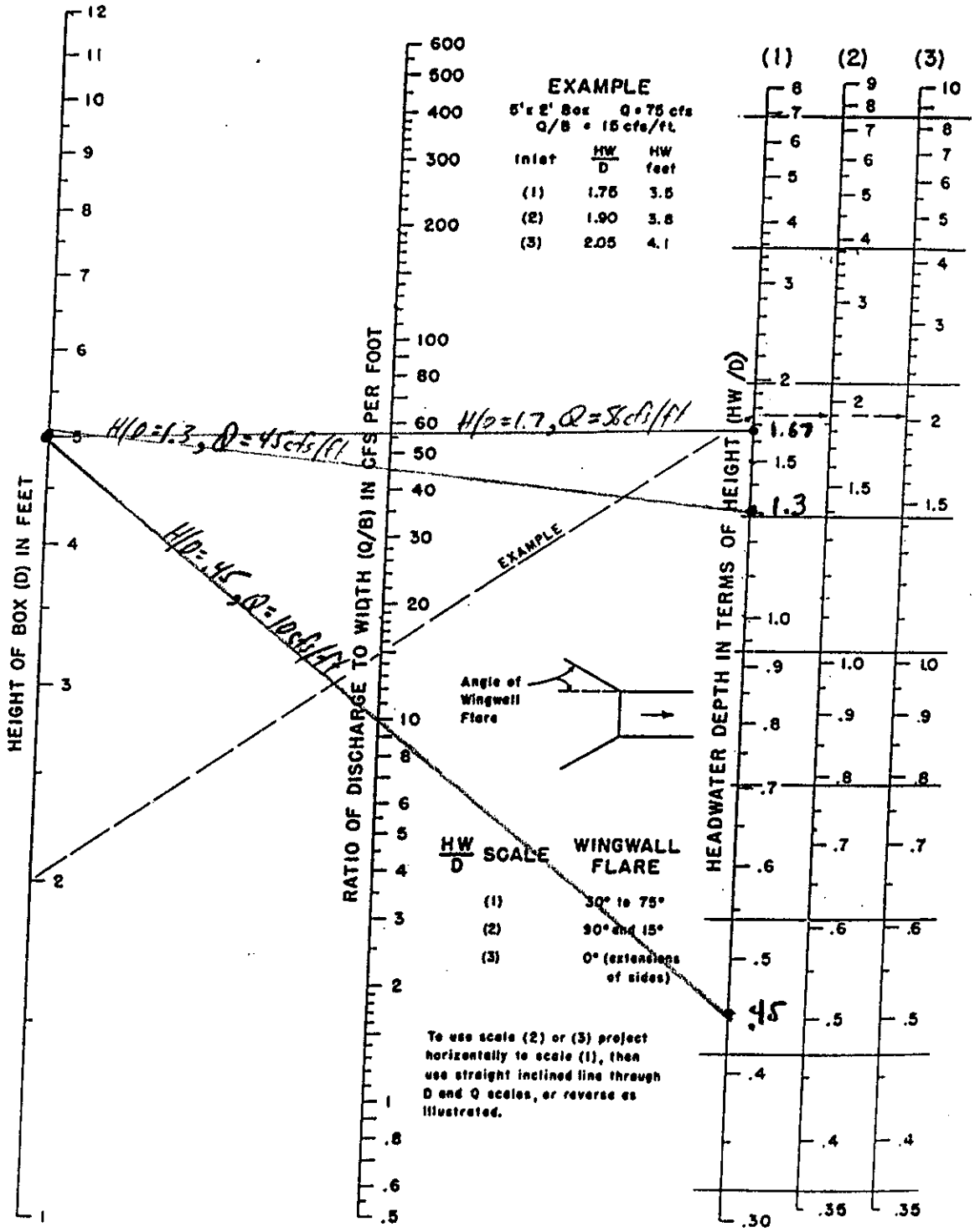
** No contour at 1983.1, linear interpolation used to estimate Storage:

$\frac{(.79-.08)}{(1980-1976)}(1983.1-1980) + .79 = 1.34$ acres

Sheet 1 of 3

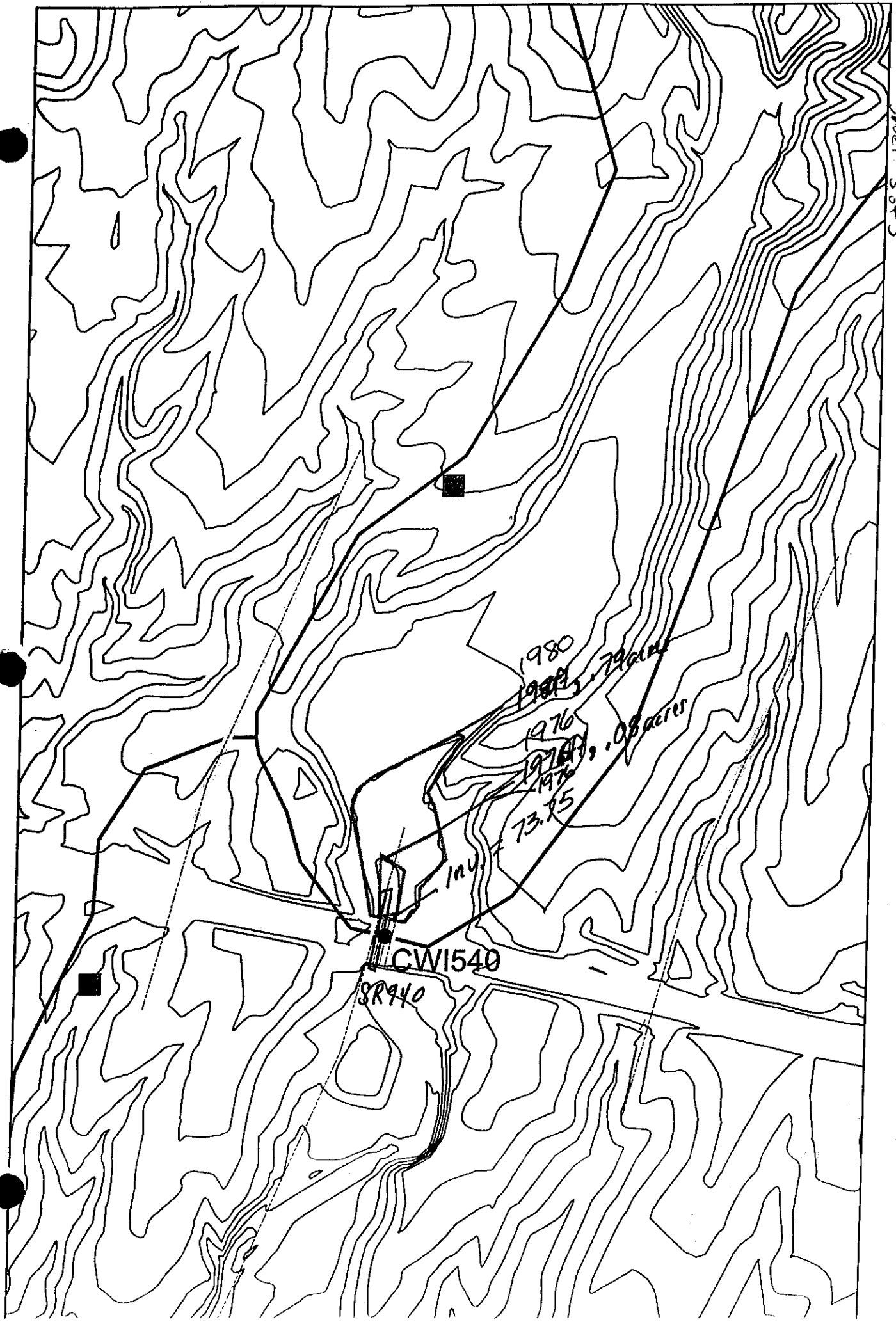
Sheet 2 of 3

CW1540



56 x 10 = 560
560
3
1680

Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)



Sheet 3 of 3

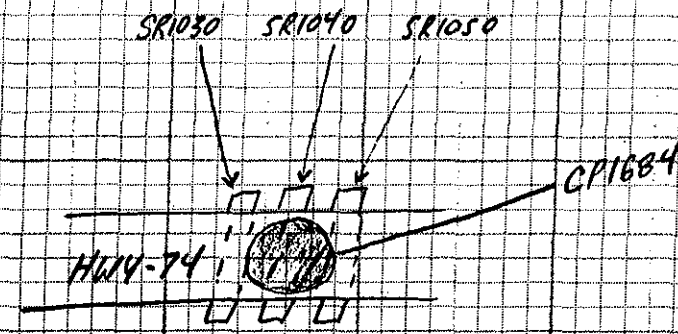
Hwy 74 at CPI684

Entellus™

SHEET 1 OF 6
BY DS DATE 3/31/4
CHECK ____ DATE ____

CLIENT FCD
JOB NAME Wittmann AOMSU JOB NO. 310032

STAGE - STORAGE - DISCHARGE : CP1684



Preliminary Q @ CP1684 = 7381 cfs

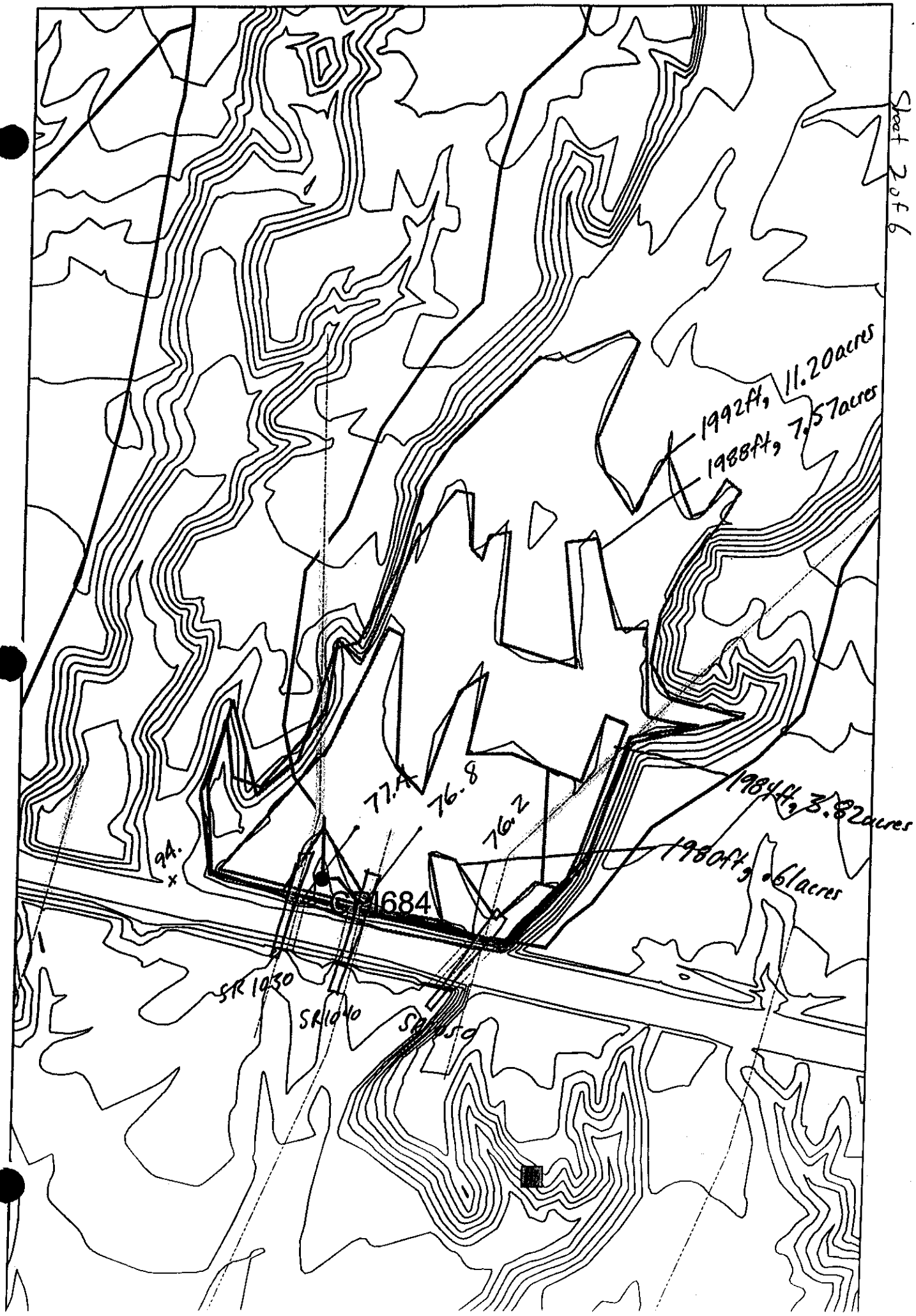
SR1030: 2 - 10×8 RCB, Invert at 1977.4
SR1040: 3 - 10×8 RCB Invert at 1976.8
SR1050: 4 - 10×8 RCB, Invert at 1976.17

Elevation (ft)	Storage (acres)	SR1030 Q (cfs)	SR1040 Q (cfs)	SR1050 Q (cfs)	TOTAL Q (cfs)
1978	0	60₁	180₁	512₁	752
1980	.61	250₁	540₁	920₂	1710
1984	3.82	1040₂	1830₂	2680₂	5550
1988	7.57	1860₂	3090₂	3328₂	8278
1992*	11.2	2600₂	3900₂	5240₂	11740

* overtopping flow

Max HWD = 18 ft abv inv. at SR1050 or 94.
per ADOD A.B

1 Estimated using H48
2 Estimated using nomograms


Sheet 2 of 6
1992ft, 11.20acres
1988ft, 7.57acres
1984ft, 3.82acres
1980ft, .61acres
77.4
76.8
76.2
94.
GP1684
SR 1030
SR1040
SR1050

30	1984.9	1	1	1-S2n	0.4	0.66	0.36	0.53	8.45	2.7
40	1985.11	1.21	1.21	1-S2n	0.52	0.79	0.53	0.63	7.49	3.01
50	1985.3	1.4	1.4	1-S2n	0.59	0.92	0.52	0.71	9.6	3.27
60	1985.48	1.58	1.58	1-S2n	0.66	1.04	0.7	0.8	8.57	3.49
70	1985.65	1.75	1.75	1-S2n	0.72	1.15	0.78	0.87	8.94	3.69
80	1985.81	1.91	1.91	1-S2n	0.79	1.26	0.86	0.94	9.33	3.87
90	1985.97	2.07	2.07	1-S2n	0.86	1.36	0.93	1.01	9.65	4.04
100	1986.12	2.22	2.22	1-S2n	0.93	1.46	1.01	1.08	9.89	4.2

El. inlet face invert 1983.9 ft El. outlet invert 1983 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR1020

PERFORM CURVE FOR CULVERT 1 - 1(5 (ft) BY 5 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1975.96	0	0	0-NF	0	0	0	0	0	0
70	1979.3	3.34	3.34	1-S2n	1.67	2.35	1.8	1.14	10.96	5.01
140	1981	5.04	5.04	5-S2n	2.47	3.38	2.7	1.68	12.94	6.22
210	1983	7.04	7.04	5-S2n	3.19	4.1	3.46	2.1	14.47	7.03
280	1985.83	9.87	9.87	5-S2n	4.02	4.63	4.22	2.46	15.9	7.64
350	1989.51	13.55	11.45	6-S2n	5	5	4.9	2.77	18.01	8.14
420	1993.94	17.98	14.76	6-S2n	5	5	4.9	3.04	21.62	8.57
490	1999.24	23.28	18.66	6-S2n	5	5	4.9	3.3	25.22	8.95
560	2006.19	30.23	23.17	6-S2n	5	5	4.9	3.54	28.82	9.28
630	2016.54	40.58	28.28	6-S2n	5	5	4.9	3.75	32.42	9.59
700	2033.47	57.51	33.99	6-S2n	5	5	4.9	3.96	36.03	9.86

El. inlet face invert 1975.96 ft El. outlet invert 1974.9 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR1030

PERFORM CURVE FOR CULVERT 1 - 2(10 (ft) BY 8 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1977.4	0	0	0-NF	0	0	0	0	0	0
58	1978.39	0.99	0.99	1-S2n	0.28	0.64	0.34	0.75	8.51	3.62
116	1978.95	1.55	1.55	1-S2n	0.57	1.02	0.68	1.12	8.58	4.64
174	1979.42	2.02	2.02	1-S2n	0.83	1.33	0.9	1.42	9.66	5.35
232	1979.85	2.45	2.45	1-S2n	0.98	1.61	1.1	1.68	10.51	5.9
290	1980.24	2.84	2.84	1-S2n	1.12	1.87	1.3	1.92	11.13	6.36

Sheet 3 of 6

348	1980.61	3.21	3.21	1-S2n	1.27	2.12	1.5	2.13	11.64	6.75
406	1980.96	3.56	3.56	1-S2n	1.42	2.34	1.67	2.32	12.13	7.09
464	1981.29	3.89	3.89	1-S2n	1.57	2.56	1.85	2.51	12.52	7.4
522	1981.62	4.22	4.22	1-S2n	1.7	2.77	2.02	2.68	12.91	7.68
580	1981.93	4.53	4.53	1-S2n	1.81	2.97	2.17	2.84	13.34	7.94

El. inlet face invert 1977.4 ft El. outlet invert 1976.5 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR1040

PERFORM CURVE FOR CULVERT 1 - 3(10 (ft) BY 8 (ft)) RCB

Concentration Point: CPI684

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1976.8	0	0	0-NF	0	0	0	0	0	0
90	1977.39	0.59	0.59	1-S2n	0.26	0.66	0.4	0.91	7.59	4.52
180	1977.81	1.01	1.01	1-S2n	0.51	1.04	0.54	1.37	11.11	5.77
270	1978.13	1.33	1.33	1-S2n	0.77	1.36	0.83	1.74	10.81	6.63
360	1978.44	1.64	1.64	1-S2n	0.92	1.65	1.02	2.05	11.75	7.29
450	1978.69	1.89	1.89	1-S2n	1.05	1.92	1.21	2.33	12.44	7.84
540	1978.94	2.14	2.14	1-S2n	1.19	2.16	1.39	2.58	12.92	8.31
630	1979.19	2.39	2.39	1-S2n	1.32	2.4	1.56	2.82	13.48	8.72
720	1979.4	2.6	2.6	1-S2n	1.45	2.62	1.72	3.04	13.95	9.09
810	1979.61	2.81	2.81	1-S2n	1.59	2.84	1.9	3.24	14.25	9.43
900	1979.82	3.02	3.02	1-S2n	1.7	3.04	2.04	3.44	14.7	9.73

El. inlet face invert 1976.8 ft El. outlet invert 1975.3 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR1050

PERFORM CURVE FOR CULVERT 1 - 4(10 (ft) BY 8 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1976.42	0	0	0-NF	0	0	0	0	0	0
128	1977.05	0.63	0.63	1-S2n	0.26	0.68	0.28	1.07	11.27	5.38
256	1977.47	1.05	1.05	1-S2n	0.51	1.09	0.63	1.61	10.23	6.84
384	1977.81	1.39	1.39	1-S2n	0.77	1.42	0.84	2.04	11.39	7.84
512	1978.13	1.71	1.71	1-S2n	0.92	1.72	1.03	2.4	12.38	8.6
640	1978.39	1.97	1.97	1-S2n	1.05	2	1.23	2.72	13.01	9.23
768	1978.66	2.24	2.24	1-S2n	1.18	2.26	1.41	3.02	13.63	9.77
896	1978.91	2.49	2.49	1-S2n	1.32	2.5	1.58	3.29	14.15	10.25
1024	1979.13	2.71	2.71	1-S2n	1.45	2.74	1.74	3.54	14.75	10.67

Sheet 4 of 6.

1152	1979.35	2.93	2.93	1-S2n	1.58	2.96	1.92	3.78	15	11.06
1280	1979.58	3.16	3.16	1-S2n	1.69	3.18	2.08	4.01	15.42	11.41

ÀÀ

El. inlet face invert 1976.42 ft El. outlet invert 1974.7 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR1070

PERFORM CURVE FOR CULVERT 1 - 1(3.5 (ft) BY 3.5 (ft))

ÀÀ

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	1984.8	0	0	0-NF	0	0	0	0	0	0
28	1987.09	2.29	2.29	1-S2n	1.01	1.62	1.06	0.76	11.34	4.36
56	1988.25	3.45	3.45	1-S2n	1.47	2.34	1.6	1.12	13.1	5.43
84	1989.59	4.79	4.79	5-S2n	1.86	2.85	2.05	1.4	14.38	6.14
112	1991.47	6.67	6.67	5-S2n	2.24	3.2	2.46	1.63	15.48	6.68
140	1993.93	9.13	7.14	6-S2n	2.66	3.5	2.87	1.84	16.62	7.12
168	1996.88	12.08	9.62	6-S2n	3.5	3.5	3.4	2.03	17.73	7.5
196	2000.39	15.59	12.55	6-S2n	3.5	3.5	3.4	2.2	20.68	7.83
224	2004.86	20.06	15.93	6-S2n	3.5	3.5	3.4	2.35	23.63	8.12
252	2011.31	26.51	19.76	6-S2n	3.5	3.5	3.4	2.5	26.59	8.39
280	2021.57	36.77	24.04	6-S2n	3.5	3.5	3.4	2.64	29.54	8.63

ÀÀ

El. inlet face invert 1984.8 ft El. outlet invert 1982.8 ft
El. inlet throat invert 0 ft El. inlet crest 0 ft

SR110

PERFORM CURVE FOR CULVERT 1 - 1(5 (ft) BY 5 (ft)) CSP

ÀÀ

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	2029.4	0	0	0-NF	0	0	0	0	0	0
44	2032.49	2.76	3.09	2-M2c	1.92	1.84	1.84	0.99	6.69	3.72
88	2033.96	4.21	4.56	2-M2c	2.87	2.65	2.65	1.46	8.32	4.64
132	2035.21	5.69	5.81	2-M2c	3.88	3.28	3.28	1.84	9.69	5.26
176	2036.92	7.52	7.27	2-M2c	5	3.79	3.79	2.15	11.06	5.73
220	2039.29	9.89	9.61	2-M2c	5	4.18	4.18	2.42	12.59	6.11
264	2042.31	12.91	12.66	2-M2c	5	4.51	4.51	2.67	14.17	6.44
308	2046.02	16.62	16.07	2-M2c	5	4.84	4.84	2.9	15.96	6.73
352	2050.39	20.99	19.8	6-S2n	5	5	4.9	3.11	18.12	6.98
396	2055.34	25.94	23.99	6-S2n	5	5	4.9	3.3	20.38	7.22
440	2060.76	31.36	28.68	6-S2n	5	5	4.9	3.49	22.64	7.43

ÀÀ

Sheet 5 of 6

Sheet 6 of 6

SR1030, 1040 and 1050

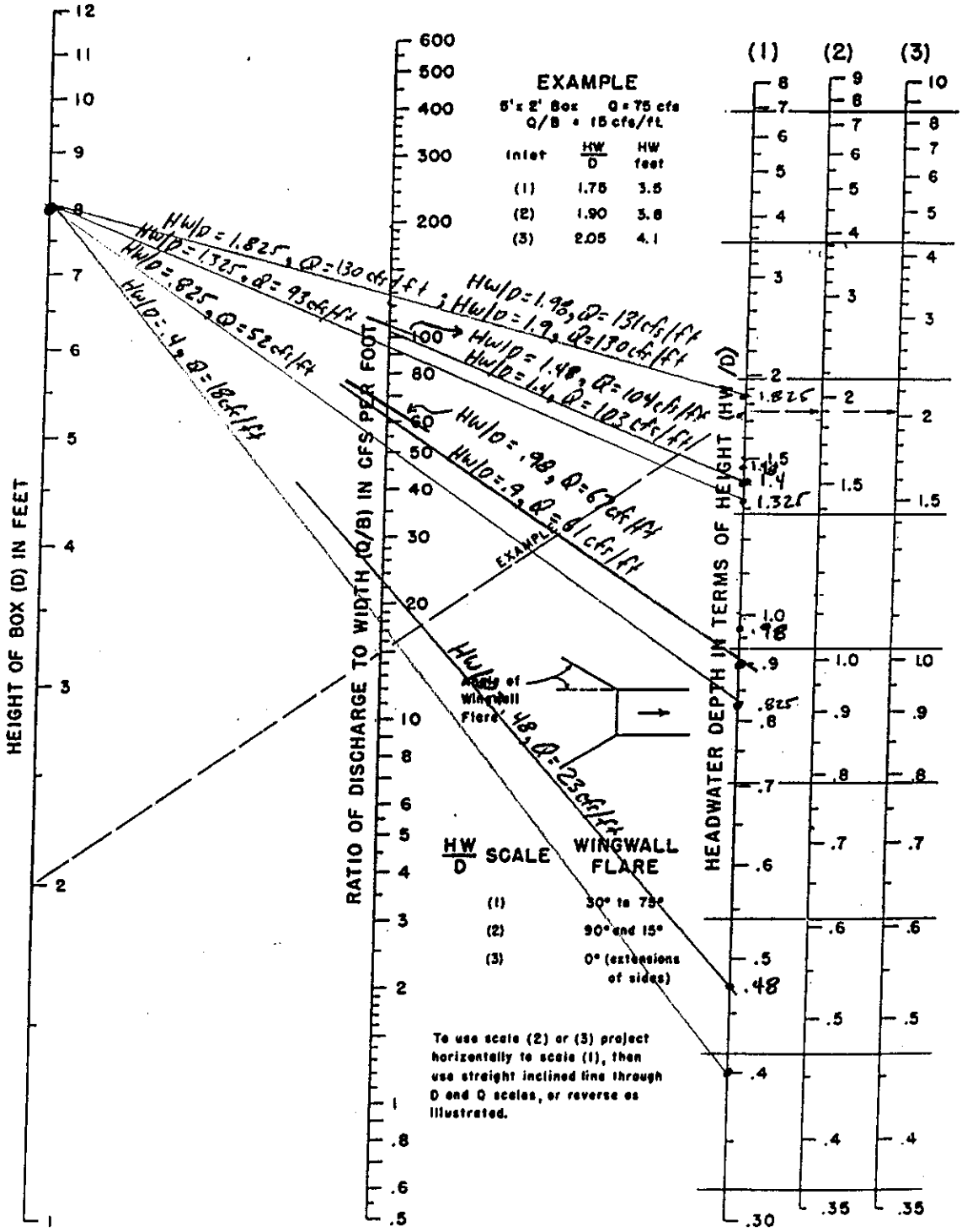


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

D.5. Flow Splits and Diversions Data

D.5.1. CAP Split Data

D.5.2. US 60 (Grand Ave) Diversion Data

D.5.3. Natural Diversion Data

D.5.4. 2-Dimensional Modeling Diversion Data

D.5.1. CAP Split Data

APPENDIX D.5.1

Entellus

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Diversion Calculations Based on Ponding at STOR1 along CAP Canal:

In order to determine the Split Flows at the CAP Canal, the following table was utilized in which the relative percentage of flow through the routes/diversions was calculated based upon the CAP structures flowing into the routes. As shown below, structure CAP070 flows through diversion DCAP07, etc. The flows for the various structures as calculated in Appendix D.4 are shown in the table below. The flows were utilized to calculate the percentage of flow that will pass through a giveHEC-1 diversion at a given stage. The Peak Stage as determined by the HEC-1 output is 1555.2.

Route

Stage	RWI542		DCAP07		DCAP08		DCAP09		DCAP10		DCAP11		DCAP12		DCAP13		DCAP14		DCAP*[a]		RDCPOT	
1558	CAP060 =	465	CAP070 =	465	CAP080 =	465	CAP090 =	480	CAP100 =	480	CAP110 =	480	CAP120=	480	CAP130 =	480	CAP140 =	430	DCAP* =	24000		
	Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow				Basin Weir Flow	
		15540		16796		3139		37487		26797		8438		9223		19495		21256				18093
	Sum	16005		17261		3604		37967		27277		8918		9703		19975		21686				18093
	% of total	9%		10%		2%		21%		15%		5%		5%		11%		12%				10%
1557	CAP060 =	440	CAP070 =	440	CAP080 =	440	CAP090 =	455	CAP100 =	465	CAP110 =	465	CAP120=	455	CAP130 =	455	CAP140 =	415	DCAP* =	13000		
	Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow				Basin Weir Flow	
		5494		5938		1110		13253		9474		2983		3261		6893		7515				6397
	Sum	5934		6378		1550		13708		9939		3448		3716		7348		7930				6397
	% of total	9%		10%		2%		21%		15%		5%		6%		11%		12%				10%
1556	CAP060 =	415	CAP070 =	430	CAP080 =	430	CAP090 =	430	CAP100 =	440	CAP110 =	440	CAP120=	430	CAP130 =	440	CAP140 =	380	DCAP* =	6050		
	Sum	415		430		430		430		440		440		430		440		380				0
	% of total	11%		11%		11%		11%		11%		11%		11%		11%		10%				0%
1554	CAP060 =	370	CAP070 =	375	CAP080 =	375	CAP090 =	380	CAP100 =	390	CAP110 =	400	CAP120=	380	CAP130 =	390	CAP140 =	335	DCAP* =	150		
	Sum	370		375		375		380		390		400		380		390		335				0
	% of total	11%		11%		11%		11%		11%		12%		11%		11%		10%				0%
1552	CAP060 =	305	CAP070 =	320	CAP080 =	320	CAP090 =	335	CAP100 =	345	CAP110 =	345	CAP120=	335	CAP130 =	335	CAP140 =	260	DCAP* =	0		
	Sum	305		320		320		335		345		345		335		335		260				0
	% of total	11%		11%		11%		12%		12%		12%		12%		12%		9%				0%
1550	CAP060 =	238	CAP070 =	238	CAP080 =	245	CAP090 =	260	CAP100 =	270	CAP110 =	270	CAP120=	260	CAP130 =	270	CAP140 =	172	DCAP* =	0		
	Sum	238		238		245		260		270		270		260		270		172				0
	% of total	11%		11%		11%		12%		12%		12%		12%		12%		8%				0%
1546	CAP060 =	55	CAP070 =	65	CAP080 =	65	CAP090 =	82	CAP100 =	91	CAP110 =	95	CAP120=	82	CAP130 =	76	CAP140 =	27	DCAP* =	0		
	Sum	55		65		65		82		91		95		82		76		27				0
	% of total	9%		10%		10%		13%		14%		15%		13%		12%		4%				0%
1544	CAP060 =	15	CAP070 =	19	CAP080 =	22	CAP090 =	27	CAP100 =	32	CAP110 =	32	CAP120=	27	CAP130 =	32	CAP140 =	0	DCAP* =	0		
	Sum	15		19		22		27		32		32		27		32		0				0
	% of total	7%		9%		11%		13%		16%		16%		13%		16%		0%				0%

[a] DCAP* is a diversion from STOR1 to STOR2. This occurs when the Ponding elevation surpasses 1552

	Storage Area sq. mi		
100-yr, 24-hr Existing	40	**53.75**	80
Peak Stage	1555.29	**1555.23**	1555.12

	Storage Area sq. mi		
100-yr, 6-hr Existing	16	**53.75**	90
Peak Stage	1555.52	**1555.01**	1554.52

	Storage Area sq. mi		
100-yr, 24-hr Future	40	**53.75**	80
Peak Stage	1555.72	**1555.67**	1555.58

	Storage Area sq. mi		
100-yr, 24-hr Future	16	**53.75**	90
Peak Stage	1556.02	**1555.62**	1555.24

Entellus

CLIENT: FCDMC

JOB NO. 310.032

JOB: Wittmann Area Drainage Master Study Update

Diversion Calculations Based on Ponding at STOR2 along CAP Canal:

In order to determine the Split Flows at the CAP Canal, the following table was utilized in which the relative percentage of flow through the routes/diversions was calculated based upon the CAP structures flowing into the routes. As shown below, structure CAP150 flows through diversion DCAP16, etc. The flows for the various structures as calculated in **Appendix D.4** are shown in the table below. The flows were utilized to calculate the percentage of flow that will pass through a given HEC-1 diversion at a given stage. The Peak Stage as determined by the HEC-1 output is 1552.

Route

Stage	DCAP15		DCAP16		DCAP17		DCAP18		DCAP19		RDCPOT	
1558	CAP150 =	465	CAP160 =	1560	CAP170=	520	CAP180 =	520	CAP190 =	1560		
	Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow	
		8610		14876		15724		6866		12532		18093
		9075		16436		16244		7386		14092		18093
		11%		20%		20%		9%		17%		22%
1557	CAP150 =	455	CAP160 =	1440	CAP170=	480	CAP180 =	480	CAP190 =	1500		
	Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow		Basin Weir Flow	
		3044		5259		5559		2428		4431		6397
		3499		6699		6039		2908		5931		6397
		11%		21%		19%		9%		19%		20%
1556	CAP150 =	430	CAP160 =	1395	CAP170=	465	CAP180 =	465	CAP190 =	1395		
		430		1395		465		465		1395		0
		10%		34%		11%		11%		34%		0%
1554	CAP150 =	380	CAP160 =	1290	CAP170=	430	CAP180 =	430	CAP190 =	1290		
		380		1290		430		430		1290		0
		10%		34%		11%		11%		34%		0%
1552	CAP150 =	320	CAP160 =	1125	CAP170=	370	CAP180 =	375	CAP190 =	1140		
		320		1125		370		375		1140		0
		10%		34%		11%		11%		34%		0%
1550	CAP150 =	245	CAP160 =	900	CAP170=	300	CAP180 =	310	CAP190 =	945		
		245		900		300		310		945		0
		9%		33%		11%		11%		35%		0%
1546	CAP150 =	66	CAP160 =	420	CAP170=	140	CAP180 =	145	CAP190 =	450		
		66		420		140		145		450		0
		5%		34%		11%		12%		37%		0%
1544	CAP150 =	22	CAP160 =	165	CAP170=	55	CAP180 =	55	CAP190 =	195		
		22		165		55		55		195		0
		4%		34%		11%		11%		40%		0%

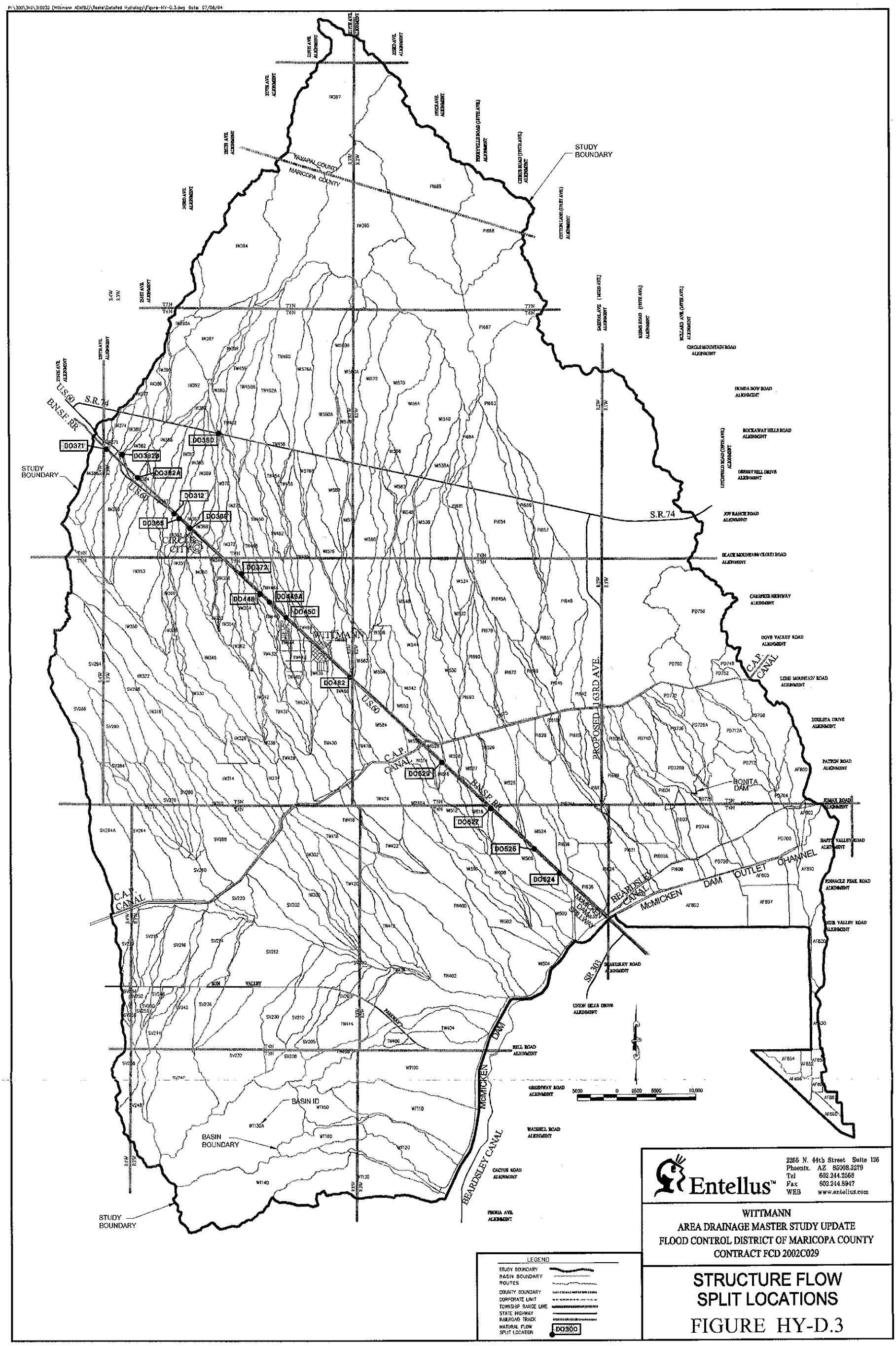
		Storage Area sq. mi	
100-yr, 24-hr Existing	20	**39.36**	40
Peak Stage	1550.40	**1550.13**	1550.12

		Storage Area sq. mi	
100-yr, 6-hr Existing	16	**39.36**	90
Peak Stage	1550.40	**1550.06**	1549.33

		Storage Area sq. mi	
100-yr, 24-hr Future	20	**39.36**	40
Peak Stage	1553.32	**1552.73**	1552.71

		Storage Area sq. mi	
100-yr, 24-hr Future	16	**39.36**	90
Peak Stage	1553.88	**1553.01**	1551.12

D.5.2. US 60 (Grand Ave) Diversion Data


STUDY BOUNDARY
YAVAPAI COUNTY
MARICOPA COUNTY
WITTMANN
CIRCLE CITY
U.S.60
S.R.74
B.N.S.F. RR
C.A.P. CANAL
BARSE RD.
PROPOSED 163RD AVE.
BEARDSLEY CANAL
McMICKEN DAM OUTLET CHANNEL
McMICKEN DAM SPILLWAY
McMICKEN DAM
BONITA DAM
SR 303
BASIN ID
BASIN BOUNDARY
DO371
DO382B
DO382A
DO380
DO312
DO368
DO366
DO372
DO448
DO446A
DO450
DO482
DO529
DO527
DO526
DO524
LEGEND
STUDY BOUNDARY
BASIN BOUNDARY
ROUTES
COUNTY BOUNDARY
CORPORATE LIMIT
TOWNSHIP RANGE LINE
STATE HIGHWAY
RAILROAD TRACK
NATURAL FLOW SPLIT LOCATION
DO300
Entellus™
2255 N. 44th Street Suite 125
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Tel 602.244.2566
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WEB www.entellus.com
WITTMANN
AREA DRAINAGE MASTER STUDY UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029
STRUCTURE FLOW SPLIT LOCATIONS
FIGURE HY-D.3

US60 and BNSF Railroad Culverts

1) Summary Spreadsheet

2) Memo 3-31-4 (regarding modeling procedures)

3) Typical Calculations sheet and structure ID's

4) Stage – Diversion / Storage Estimations by Structure ID

Existing Structures - BNSF Railroad

RR ID #	Main Flow to Concentration Point ID [3]	Structure Diverts Flow to	# of Barrels	Width or Diameter	Height	Type[4]	Station [2]	Modeling Notes [1]
10	none	none	2	4'	2'	W-Box	2501+00	C
20	none	none	1	3'	3'	W-Box	150+54	E,F
30	none	none	1	4'	3'	W-Box	150+6	E,F
40	CIW371	CIW374	1	4'	3'	RCB	150+7	B
50	CIW374	none	2	3'	3'	RCB	151+0	C
60	none	none	1	34"		RCP	151+1	D
70	none	none	1	42"		CMP	151+16	D
80	none	none	1	48"		CMP	151+25	D
90	CIW382	RR100	1	4'	6'	HPA	151+64	B
100	CIW382	CIW384	1	36"		CMP	151+77	B
110	CIW384	none	1	53"		RCP	151+91	E,F
120	none	none	1	35"		RCP	152+05	E,F
130	none	none	1	4'	2'	W-Box	152+19	E,F
140	CIW388	none	9	13'	8'	W-Bri	152+37	C
150	none	none	1	3'	4'	HPA	152+55	E,F
160	none	none	2	46"		RCP	152+7	E
170	CIW312	CIW365	1	4'	6'	HPA	153+0	B
180	CIW365	none	1	27"		RCP	153+15	A,E,F
190	CIW365	RR200	1	3'	5'	HPA	153+17	B
200	CIW365	CIW367	1	46"		RCP	153+26	B
210	none	none	1	2'	2'	W-Box	153+34	E,F
220	none	none	1	26"		RCP	153+40	E,F
230	none	none	1	42"		RCP	153+44	E,F
240	CIW369	CIW368	2	3'	3'	RCB	153+5	B
250	none	none	1	2'	2'	W-Box	153+64	E,F
260	none	none	1	2'	1'	W-Box	153+7	E,F
270	CIW368	none	1	4'	5'	HPA	153+9	C
280	none	none	2	8'	6'	W-Bri	154+0	E
290	none	none	1	24"	25"	RCP	154+1	E,F
300	none	none	1	51"		RCP	154+2	E,F
310	CIW370	none	6+	16'	8'	W-Bri	154+4	C
320	none	none	1	3'	3'	W-Box	154+5	E,F
330	none	none	1	37"		RCP	154+6	E,F
340	CIW372	RR350	1	3'	5'	HPA	154+9	B
350	CIW372	RR360	1	39"		RCP	155+1	B
360	CIW372	CIW375	1	46"	50"	RCP	155+2	B
370	CIW375	none	2	3'	4'	RCB	155+3	C
380	none	none	1	42"	45"	RCP	155+5	E,F
390	none	none	1	24"		RCP	155+67	E,F
400	none	none	1	24"	26"	RCP	155+73	E,F
410	CTW448	CTW446A	1	3'	5'	HPA	155+8	B
420	CTW446A	RR430	1	3'	5'	HPA	156+1	B
430	CTW446A	CTW450	2	66"		CMP	156+11	B
440	none	none	1	27"		RCP	156+3	E,F
450	CTW450	CTW452	6	13'	9'	W-Bri	156+7	B
460	CTW452	none	5	13'	7'	W-Bri	157	C
470	none	none	1	2'	2'	W-Box	157+1	E,F
480	none	none	1	35"	39"	RCP	157+28	E,F
490	none	none	1	34"	32"	RCP	157+4	E,F
500	none	none	1	36"		RCP	157+8	E,F
510	CTW484	none	5	28'	8'	S-Bri	158+1	C
520	CTW482	CTW582	4	13'	8'	W-Bri	158+8	B

Existing Structures - BNSF Railroad

RR ID #	Main Flow to Concentration Point ID [3]	Structure Diverts Flow to	# of Barrels	Width or Diameter	Height	Type[4]	Station [2]	Modeling Notes [1]
530	CWI582	none	2	30"		RCP	159+2	E
540	CWI552	none	9	14'	7'	C-Bri	160+9	C
550	none	none	2	36"		RCP	161+3	E
560	none	none	2	?	7	W-Bri	161+4	E
570	none	none	1	29"	46"	RCP	161+6	E,F
580	CWI529	CWI528	1	17'	6'	S-Bri	161+8	B
590	CWI528	none	3	14'	9'	S-Bri	162+7	C
600	CWI527	RR610	2	13'	7'	S-Bri	163+2	B
610	CWI527	CWI525	2	48"		RCP	163+5	B
620	none	none	1	36"		CMP	163+86	E,F
630	CWI525	CWI524	4	14'	6'	W-Bri	164+5	B
640	none	none	2	40"		RCP	164+9	A,E
650	CWI524	CPI639	6	14'	8'	W-Bri	165+7	B
660	CPI639	none	5	14'	6'	W-Bri	166+0	E
670	none	none	1	40"		RCP	166+3	E,F
680	none	none	1	36"		RCP	166+7	E,F
690	CPI636	none	1	36"		RCP	167+1	E,F

Modeling Notes [1]: A) Culvert was not modeled because flow was assumed to pass through culvert(s) at the basin CP.
B) Culvert was modeled with a diversion to the next downstream CP or significant culvert.
C) Culvert was modeled but was found to not have any significant diversion or storage.
D) Culvert was not modeled because it has a larger capactiy than upstream US60 culverts.
E) Culvert was not modeled because it was assumed it will not cause significant storage or diversion.
F) Culvert has insignificant capacity

Station [2]: Stations are by railroad milepost and correspond to LTM Survey

Concentration Point ID [3]: Concentration point ID at railroad or US60 that main flow path from the structure contributes to.

Type[4]: CMP- Corrugated Metal Pipe
RCP- Reinforced Concrete Pipe
HPA- High Profile Arch
RCB- Reinforced Concrete Box

Existing Structures - Highway 60

ID #	HEC-1 CP ID	# of Barrels	Width or Diameter	Height	Type[2]	Station[3]	Modeling Notes [1]
US001		1	8'	3'	RCB	1386+96	C
US002			24"	60"	CMP	1391+30	C
US003		2	30"	60"	CMP	1395+69	C
US004	IW 371	2	30"		CMP	1402+93	A
US005	IW 374	1	6'	4'	RCB	1415+93	A
US006A		1	36"	70"	CMP	1423+50	C
US006B		1	50"	31"	CMP	1423+50 WB	C
US007		1	48"		CMP	1427+34 WB	B
US008		1	48"		PC	1439+90 WB	B
US009		1	24"		CMP	1345+80 EB	A
US010	IW 381	1	36"	70"	CMP	1338+30 EB	A
US011	IW 382	1	8'	5'	RCB	1460+60	A
US012A	IW 384	1	4'	3'	RCB	1471+80 EB	A
US012B	IW 384	1	48"	94"	PC	1471+80 WB	A
US013			24"	54"	CMP	1479+92	C
US014			24"	54"	CMP	1481+55	C
US015			24"	56"	CMP	1486+35	C
US016	IW 388		100'		Bridge	1496+08	A
US017		1	6'	4'	RCB	1507+51	C
US018		1	6'	4'	RCB	1513+08	C
US020	IW 312	1	6'	5'	RCB	109+00	A
US050	IW 365	1	5'	6'	RCB	119+89	A
US080		2	42"		CMP	124+10	C
US090		2	30"		CMP	129+29	C
US110	IW 367	2	42"		CMP	135+39	A
US130	IW 369	1	6'	5'	RCB	139+64	A
US160	IW 368	1	5'	6'	RCB	158+84	A
US200		3	36"		CMP	175+69	C
US210	IW 370		10'	30'	Bridge	183+17	A
US220		2	30"		CMP	190+35	C
US240		2	36"		CMP	197+39	C
US270	IW 372	1	6'	4'	RCB	217+97	A
US290		1	10'	4'	RCB	226+48	C
US310	IW 375	1	10'	8'	RCB	233+10	A
US330		2	42"		CMP	247+71	C
US350		2	36"		CMP	256+79	C
US370	TW 448	1	6'	4'	RCB	261+36	A
US420	TW 446A	2	6'	6'	RCB	277+97	A
US450	TW 450	8	10'	6'	RCB	305+42	A
US480	TW 452	6	10'	5'	RCB	325+58	A
US560	TW 484	2	30"		RCP	378+19	A
US600	TW 482	3	10'	5'	RCB	416+73	A
US640	WI 582	4	42"		CMP	440+75	A
US690		2	24"		CMP	496+76	C
US710		2	30"		CMP	516+54	C

Existing Structures - Highway 60

ID #	HEC-1 CP ID	# of Barrels	Width or Diameter	Height	Type[2]	Station[3]	Modeling Notes [1]
US720	WI 552	1	24"		RCP	547+51	A
US730		1	24"		CMP	549+15	C
US740		2	48"		CMP	556+75	C
US750		1	42"		CMP	563+87	C
US770	WI 529	3	10'	3'	RCB	576+95.94	A
US820	WI 528	2	10'	5'	RCB	622+37.74	A
US850	WI 527	5	8'	3'	RCB	647+98.47	A
US860		3	36"		CMP	662+37	C
US880		1	36"		CMP	685+42	C
US930	WI 525	4	10'	4'	RCB	720+72.94	A
US1000	WI 524	3	8'	3'	RCB	782+07.54	A
US1010	PI 639	3	10'	4'	RCB	797+60	A
US1050		1	30"		CMP	836+42	C

Modeling Notes[1]

A) Culvert was not modeled because it has a larger capacity than the upstream railroad culverts.

B) Culvert was modeled.

C) Culvert was not modeled because all flow was assumed to pass through culvert(s) at the basin CP.

Type[2] : *CMP- Corrugated Metal Pipe*

RCP- Reinforced Concrete Pipe

RCB- Reinforced Concrete Box

Bridge

PC- Pipe Culvert

Station[3]: Stations are from US 60 As-Builts

Memo 3-31-4

4-13-04

Entellus™
2255 N. 44th St., Suite 125
Phoenix, AZ 85008
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Fax (602)244-8947
Website www.entellus.com

TO:	Attendees
FROM:	RAS, Entellus
JOB NO.:	310.032
DATE:	03/31/04

Wittmann ADMSU- Meeting Regarding US 60 and Railroad Culvert Modeling

MEMORANDUM

Re: **Project Meeting at Entellus**
March 30th, 2004

Attendees:

Collis Lovely	Entellus	Ryan Sauer	Entellus
Jacob Sweeting	Entellus		

The following is a summary of items that were discussed and concluded during the meeting of the above referenced project.

SUMMARY OF MEETING

Conclusions were made as to which culverts should be modeled along the Railroad and the US 60. The following is a detailed description of the decisions made.

CIW371

Current Modeling Method:

Diversion to CIW374 based on capacity of RR040

Final Modeling Method:

No change

Final Structure Decision:

RR010-RR030	Ignore (small contributing area-all flow passes)
RR040	Model
US001-US003	Ignore (small contributing area-all flow passes)
US004	Ignore, RR040 is controlling structure

CIW374

Current Modeling Method:

No diversion

Final Modeling Method:

No change: any potential diversion is blocked by US 60 and ends up in same basin as CIW374

Final Structure Decision:

RR050	Ignore (can pass all flow to structure)
US005	Ignore (can pass all flow to structure)

CIW381:

Current Modeling Method:

No diversion

Final Modeling Method:

Receives Diversion from CIW382

Final Structure Decision:

RR060	Ignore (can pass all flow to structure and all passing flow is assumed to go to CIW381
US006A & US006B	Ignore (can pass all flow to structure)
US007-US008	Modeled as diversion to CIW381 from CIW382

CIW382:

Current Modeling Method:

RR090 is controlling
US011 can pass anything flow through RR090
US008 is ignored, as well as RR070, RR080, RR100
Assumed diversion to CIW384 passed on RR090

Final Modeling Method:

Model RR090 and RR100 together as capacity for CIW382
Model diversion to CIW381 through US006 and US007
Modify diversion to CIW384 based on added diversion and RR100

Final Structure Decision:

RR070-RR080	Ignore (US070-080 controlling)
RR090-RR100	Model as flow passing to CIW382
US009	Ignore (insignificant compared to US010)
US010	Ignore (can pass all flow passing through US007-008)
US011	Ignore (RR090-100 controlling)

CIW384

Current Modeling Method:

No Diversion

Final Modeling Method:

No change

Final Structure Decision:

RR110	Ignore (can pass all flow to structure)
US012	Ignore (can pass all flow to structure)

IW388

Current Modeling Method:

No Diversion

Final Modeling Method:

No change

Final Structure Decision:

RR120	Ignore (no significant contributing area)
RR130-RR160	Ignore (can pass all flow to structure)
US013-US014	Ignore (no significant contributing area)
US015-US018	Ignore (can pass all flow to structure)

CIW312

Current Modeling Method:

Diversion to CIW365

Final Modeling Method:

No change

Final Structure Decision:

RR170	Model as flow to CIW312
US020	Ignore (can pass all flow to structure)

CIW365

Current Modeling Method:

Diversion to CIW367 based on RR190 only.

Final Modeling Decision:

Capacity of both RR190-200 included in diversion calculation to CIW367

Final Structure Decision:

RR180	Ignore (insignificant compared to capacity of RR190-200, and it does not appear to be receiving any flow: invert very different from other structures)
RR190-RR200	Model together as flow to CIW365
US050 and US080	Ignore (can pass all flow to structure)

CIW367

Current Modeling Method:

No diversion.

Final Modeling Decision:

No change

Final Structure Decision:

RR210-RR230	Ignore (can pass all flow to structure)
US090	Assume flow passing gets to CIW367
US110	Ignore (can pass all flow to structure)

CIW369

Current Modeling Method:

Diversion to CIW368: model RR240

Final Modeling Method:

No change

Final Structure Decision:

RR240	Model as flow to CIW369
US130	Ignore (can pass all flow to structure)

CIW368

Current Modeling Method:

Diversion to CIW370 based on capacity of RR240 only

Final Modeling Method:

Remove diversion to CIW370. RR280 flows back to CIW368 and this creates a worst-case scenario for Circle City, which is immediately downstream. Any diversion that might occur to CIW370 would be relatively insignificant.

Final Structure Decision:

RR250-RR260	Any flow from these structures does not cross US60 until structure US160 at CIW368. Ignore structure and assume all flow passes to US160.
RR270	Ignore (can pass all flow to structure)
US160	Ignore (can pass all flow to structure)

CIW370

Current Modeling Method:

No diversion

Final Modeling Method:

No change

Final Structure Decision:

RR280-RR300	Ignore (small contributing area)
RR310	Ignore (can pass all flow to structure)
US200	Ignore (small contributing area)
US210	Ignore (can pass all flow to structure)

CIW372

Current Modeling Method:

Diversion to CIW375 based on RR340

Final Modeling Method:

Model Diversion to CIW375 based on capacities of RR340, RR350 and RR360

Final Structure Decision:

RR320-RR330	Ignore (insignificant)
RR340-RR360	Model as flow passing to CIW372
US220, US240	Ignore (insignificant)
US270, US290	Ignore (can pass all flow to structure), but assume all flow through structures ends up at CIW372

CIW375

Current Modeling Method:

Diversion to CTW448

Final Modeling Method:

Remove diversion to CTW448. Culverts can handle all flow. This eliminates the problem of a diversion crossing multiple basin boundaries.

Final Structure Decision:

RR370	Ignore (can pass all flow to structure)
RR380	Ignore (small contributing area)
US310	Ignore (can pass all flow to structure)
US330	Ignore (small contributing area)

CTW448

Current Modeling Method:

Diversion to CTW450

Final Modeling Method:

Add concentration point TW446A (splitting TW446) at the US60. The flow through CTW448 only includes the capacity of RR410. A new diversion will be inserted at C446A and divert flow to CTW450. The flow through to C446A includes the capacities of culverts RR420 and RR430.

Final Structure Decision:

RR390-RR400	Ignore (small contributing area)
RR410	Model as flow passing through to CTW448
RR420-RR430	Model as flow passing through to C446A
US350	Ignore (small contributing area)
US370, US420	Ignore (can pass all flow to structure)

CTW450

Current Modeling Method:

Diversion to CTW452

Final Modeling Method:

No change

Final Structure Decision:

RR440	Ignore (small contributing are and insignificant when compared with RR450)
RR450	Model as flow passing through to CTW450
US450	Ignore (can pass all flow to structure)

CTW452

Current Modeling Method:

No diversion, no culvert modeling

Final Modeling Method:

No change.

Final Structure Decision:

RR460	Ignore (can pass all flow to structure)
US480	Ignore (can pass all flow to structure)

CTW484

Current Modeling Method:

No diversion

Final Modeling Method:

No change

Final Structure Decision:

RR470-RR500	Any flow passing through these culverts is routed along US60 until the next US60 culvert, which is structure US560.
RR510	Ignore (can pass all flow to structure)
US560	Ignore (can pass all flow to structure)

CTW482

Current Modeling Method:

Diversion to CTW582

Final Modeling Method:

No change

Final Structure Decision:

RR520	Model as flow passing through to CTW482
US600	Ignore (can pass all flow to structure)

CWI582

Current Modeling Method:

Routed along railroad: does not cross railroad or US60.

Final Modeling Method:

No change. The culvert is perched and no flow gets to culvert under current modeling conditions.

Final Structure Decision:

RR530	Model as flow passing through to CWI582
US640	Ignore (can pass all flow to structure)

CWI554

Current Modeling Method:

No diversion and route flows along railroad and US60.

*** Verify that route information is in fact the channel along the railroad.***

Final Modeling Method:

No change

Final Structure Decision:

US690, US710	No flow makes it these structures

CWI552

Current Modeling Method:

Diversion to CWI542

Final Modeling Method:

Remove diversion to CWI542. Before the diversion could occur significant ponding would happen, thus making the diversion unlikely.

Final Structure Decision:

RR540	Ignore (can pass all flow to structure)

CWI529

Current Modeling Method:

Diversion to CWI528

Final Modeling Method:

No change

Final Structure Decision:

RR550-RR570	Ignore (insignificant when compared to RR580)
RR580	Model as flow passing through to CWI529
US730-US750	Ignored because RR550-RR570 are ignored
US770	Ignore (can pass all flow to structure)

CWI528

Current Modeling Method:

No diversion

Final Modeling Method:

No change

Final Structure Decision:

RR590	Ignore (can pass all flow to structure)
US820	Ignore (can pass all flow to structure)

CWI527

Current Modeling Method:

Diversion to CWI525. Flow to CWI527 is only based on RR600

Final Modeling Method:

Keep diversion to CWI525, but add the capacity of RR610 to RR600.
Adjust concentration point location

Final Structure Decision:

RR600-RR610	Model as flow passing through to CWI527
US850-US860	Ignore (can pass all flow to structure)

CWI525

Current Modeling Method:

Diversion to CWI524. Flow to CWI525 is only based on RR630

Final Modeling Method:

No Change

Final Structure Decision:

RR620	Ignore (insignificant compared to RR630)
RR630	Model as flow passing through to CWI525
RR640	Flow through culvert is routed to next CP
US880	Ignore because RR620 is ignored
US930	Ignore (can pass all flow to structure)

CWI524

Current Modeling Method:

Diversion to WIPI639

Final Modeling Method:

Keep diversion

Adjust concentration point location

Final Structure Decision:

RR650	Model as flow passing through to CWI524
US1000	Ignore (can pass all flow to structure)

CPI639

Current Modeling Method:

No diversion

Routes to CPI636

Final Modeling Method:

No diversion

Change route to CWI506

Adjust concentration point location

Final Structure Decision:

RR660	Ignore (can pass all flow to structure)
US1010	Ignore (can pass all flow to structure)

CPI636

Current Modeling Method:

No diversion

Routes to CPI635

Adjust concentration point location

Final Modeling Method:

No diversion

Change route to CPI624

Final Structure Decision:

RR670-RR680	Ignore (minimal capacity)
RR690	Ignore. Flow through this culvert cannot cross US60, therefore the flow either ponds or flows through adjacent street culvert.
US1050	Ignore because RR670-RR680 are ignored

OTHER MODELING ISSUES:

Storage

In addition to the diversion modeling at the US60 and railroad, the issue of storage was discussed internally at Entellus and with Bill Haas. Entellus is not currently modeling any storage along the US60 and railroad. This is due to the shallow nature of the washes at these structures which would result in negligible storage. However, Entellus is modeling storage along the SR74, but no diversions. This is due to the incised nature of the washes which results in considerable storage. Because of the depth of the washes there is minimal chance for diversions to occur, thus they wer not modeled.

Southeast portion of Watershed

Several issues regarding the southeast portion of the watershed, in particular the Sun City Annex area, were discussed with Bill Haas on 03-31-04. Bill Haas provided the following information about the area.

Sun City Annex Area

This is a separate area from Sun City, and may not have been designed to retain 100-yr, 24-hr, but was probably only designed to retain the 100-yr 2-hr. There are a couple of culverts along the boundary of the area. To date Bill was not certain if this area should be included in the model.

Agriculture Area

This area is designed for a first flush only and excess runoff flows into a channel directly south. This channel was originally designed to hold 1600 cfs but supposedly its capacity was increased to 2000 cfs, but this has not been verified. This agricultural portion should be included in the watershed area.

Beardsley Canal

Bill Haas and the District has requested that the Beardsley Canal be modeled with storage. This structure needs to be looked at in detail. The assumption will be made, per Districts request, that no breaches occur in the structure.

GIS Questions

Bill Haas verified with the GIS department at the District that the intermediate concentration points that exist in the HEC-1 model, but that are located in the middle of a subbasin (to limit the number of hanging hydrographs, or other reason) do not need to be included with the GIS data.

Other Questions

Bill Haas will ask Mike Duncan at the District what need to be done (level of detail etc) with the small orphaned portion of the watershed southeast of the Sun City Annex area.

Typical Calculations and Structure ID's

Entellus™

SHEET 1 OF 3

BY JS DATE 11/03

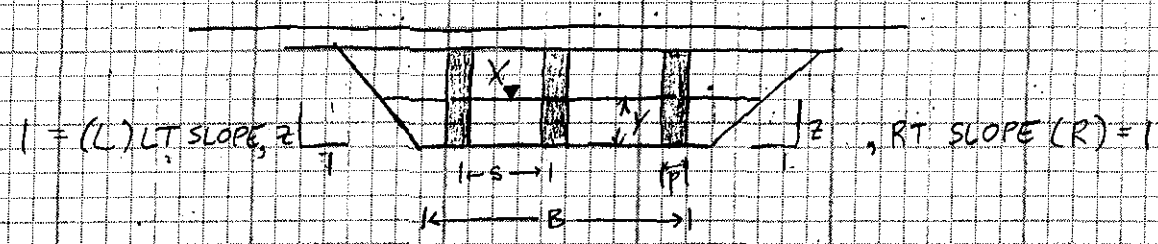
CHECK AMG DATE 1/30/04

CLIENT FCD

JOB NAME Wittmann JOB NO. 310032

NORMAL DEPTH CALCS FOR RRS20: STATION 158+80
DESCRIPTION: 4-13-8' WOODEN BRIDGE

THESE CALCULATIONS HAVE BEEN INCORPORATED INTO SPREADSHEETS IN ORDER TO MODEL FLOW CONVEYANCE UNDER THE RR BRIDGES, AND SUBSEQUENT DIVERSIONS, USING MANNING'S NORMAL DEPTH EQUATIONS. RRS20 WAS CHOSEN BECAUSE IT IS THE MOST INVOLVED. FOR BRIDGES, A CLOGGING FACTOR WAS USED TO ACCOUNT FOR THE PIERS.



S (ft) = 13 (AVERAGE SPACE BETWEEN PILINGS)
n = 3 (NUMBER OF PILINGS)
p(ft) = 1 (WIDTH OF PILINGS)

CLOGGING FACTOR = np(1.5) = 3·1(1.5) = 4.5 ft

B(ft) = 31.5 (ACTUAL BOTTOM WIDTH)
W(ft) = B - CLOGGING FACTOR = 31.5 - 4.5 = 27 ft (ADJUSTED BOTTOM WIDTH)

Y(ft) = X - INVERT ELEVATION = X - 1645.81 (DEPTH)

A(ft²) = YW + 1/2 Y²(R + L) (FLOW AREA)
= (X - 1645.81)27 + ½(X - 1645.81)²(2)

P(f) = W + (YR² + Y²)^½ + (YL² + Y²)^½ (WETTED PERIMETER)

S = UPSTREAM INVERT - DOWNSTREAM INVERT / DOWNSTREAM STATION (SLOPE)

S = 1648 - 1646 / 259 = .0077

$$Q = \frac{1.486 A^{5/3} S^{1/2}}{N P^{2/3}}$$ (MANNINGS EQUATION)

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SHEET 2 OF 3

BY N DATE 11/03

CHECK AMG DATE 1/30/04

CLIENT FCO

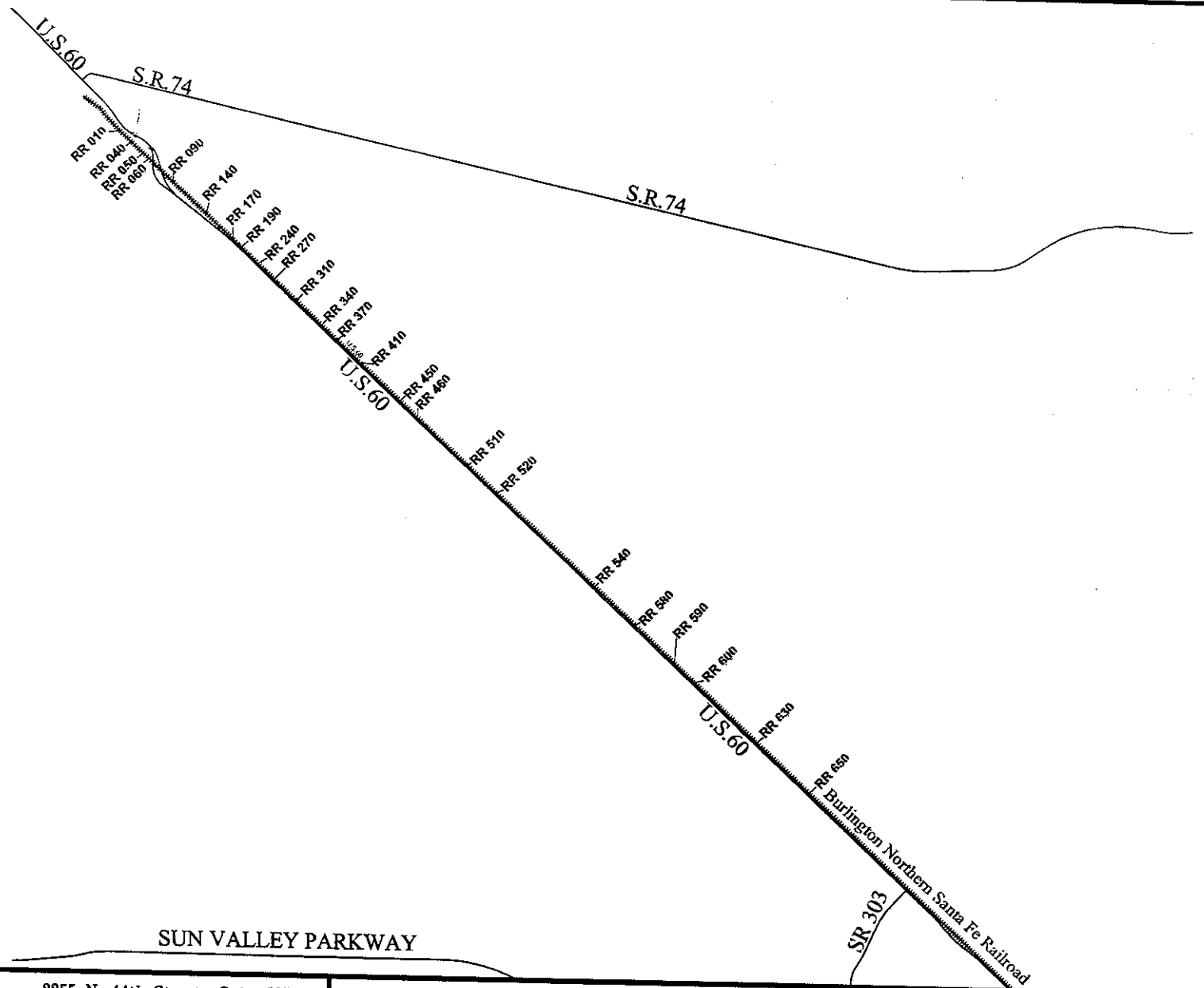
JOB NAME Wittmann JOB NO. 310032

N = .035 (ROUGHNESS)

$$Q = \frac{1.486\left[(X-1645.81)27 + (X-1645.81)^2\right]^{5/3} .0077^{1/2}}{.035\left[27 + \left[((X-1645.81)+(X-1645.81)^2)^{1/2}\right]2\right]^{2/3}}$$

X (ELEVATION) ft	Y (DEPTH) ft	Q (DISCHARGE) CFS
1646	.19	6.2
1648	2.19	376
1650	4.19	1143
1652	6.19	2265
1653	7.19	2958

Sheet 3 of 3



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WITTMANN
AREA DRAINAGE MASTER STUDY UPDATE (ADMSU)
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 2002C029

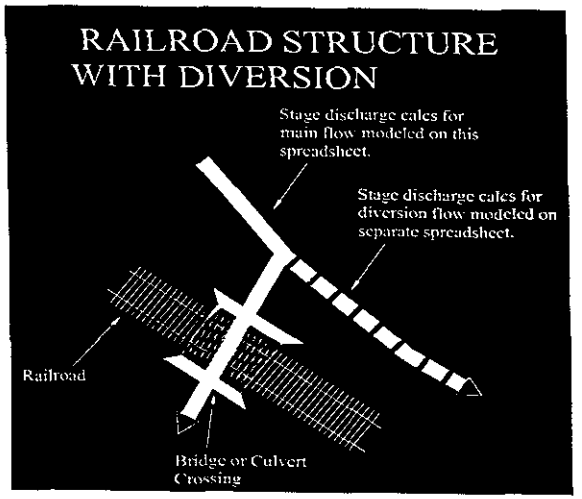
MODELED STRUCTURES ALONG THE
BURLINGTON NORTHERN SANTA FE RAILROAD
Appendix D.5.2

RR10

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D.5.2

Entellus ID RR10
Station 148+54
Description 2 - 4 x 2 Box Culverts

Sketch



Nomograph Input	
Culvert Invert Elevation (ft)	1968.7
Spilling Stage Elevation (ft)	1972
Width (ft)	4
Height (ft)	2
Number of Boxes	2

	Stage Elevation				
	1968.7	1972	1972.5	1973	1973.5
Headwater Depth (ft)	0.00	3.30	3.80	4.30	4.80
Headwater Depth / Height	0.00	1.65	1.90	2.15	2.40
Ratio of Discharge to Width (cfs/ft)	0.00	12.80	14.10	15.70	17.20
Discharge (cfs)	0.0	102.4	112.8	125.6	137.6
Diversion Discharge (cfs)	0.0	0.0	358.9	1136.9	1988.4
Total Discharge (cfs)	0.00	102.40	471.72	1262.54	2126.00
Storage Area (acres)	0	0	0	0	0

WLB flow (cfs) No Similar Concentration Point
Calculated flow at spilling elevation (cfs) 102.0
Model Diversion? Yes

Note: Diversion does not pass to next concentration point because the flow can't get there (US60 is in the way). Therefore the diversion has not been included in the HEC-1 model.

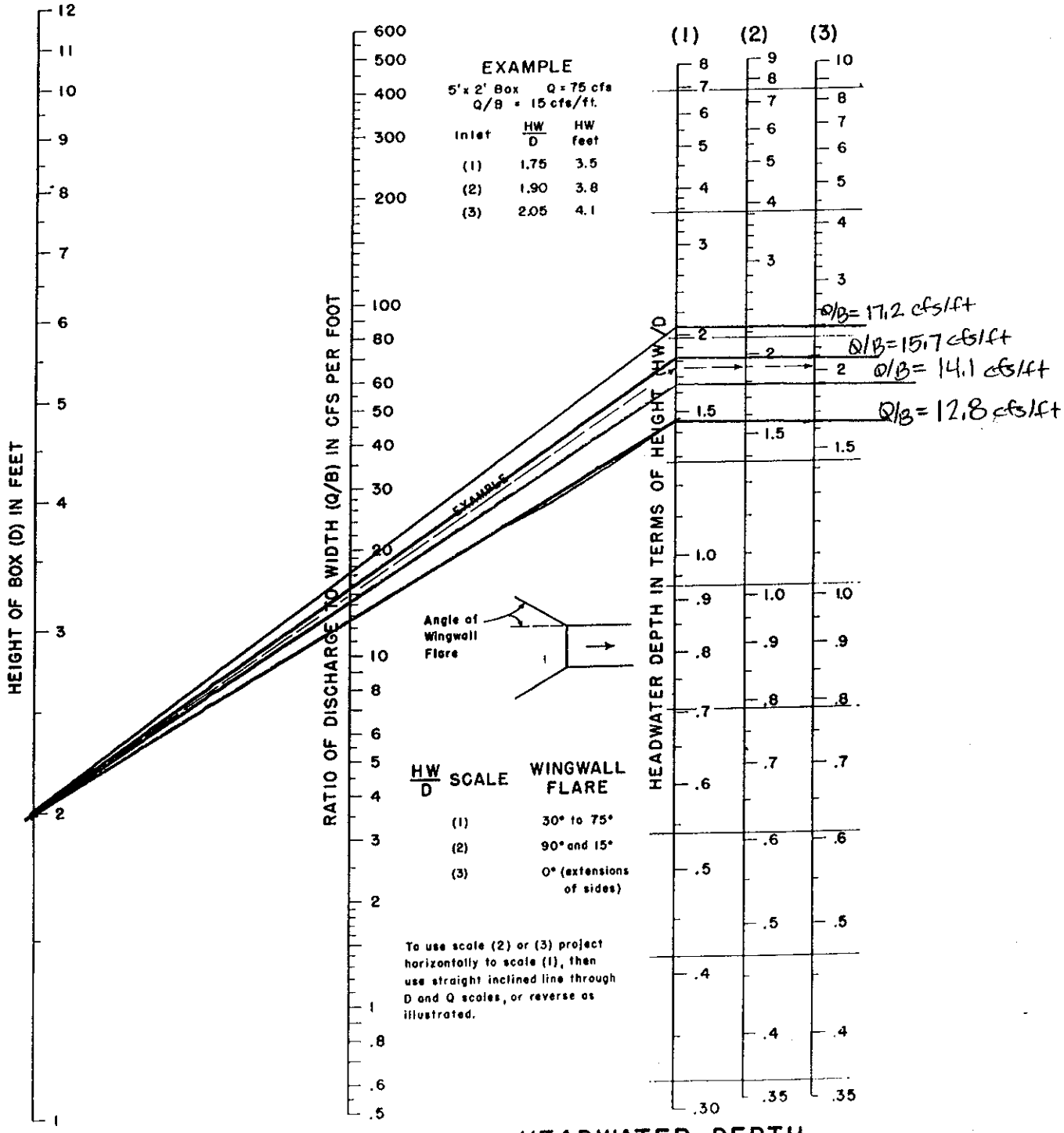
Entellus™

SHEET 2 OF 4
BY AMG DATE 1/29/04
CHECK ____ DATE ____

CLIENT FCDMC
JOB NAME Wittmann ADMSU
JOB NO. 310.032

RR#10 (ST 148+54)

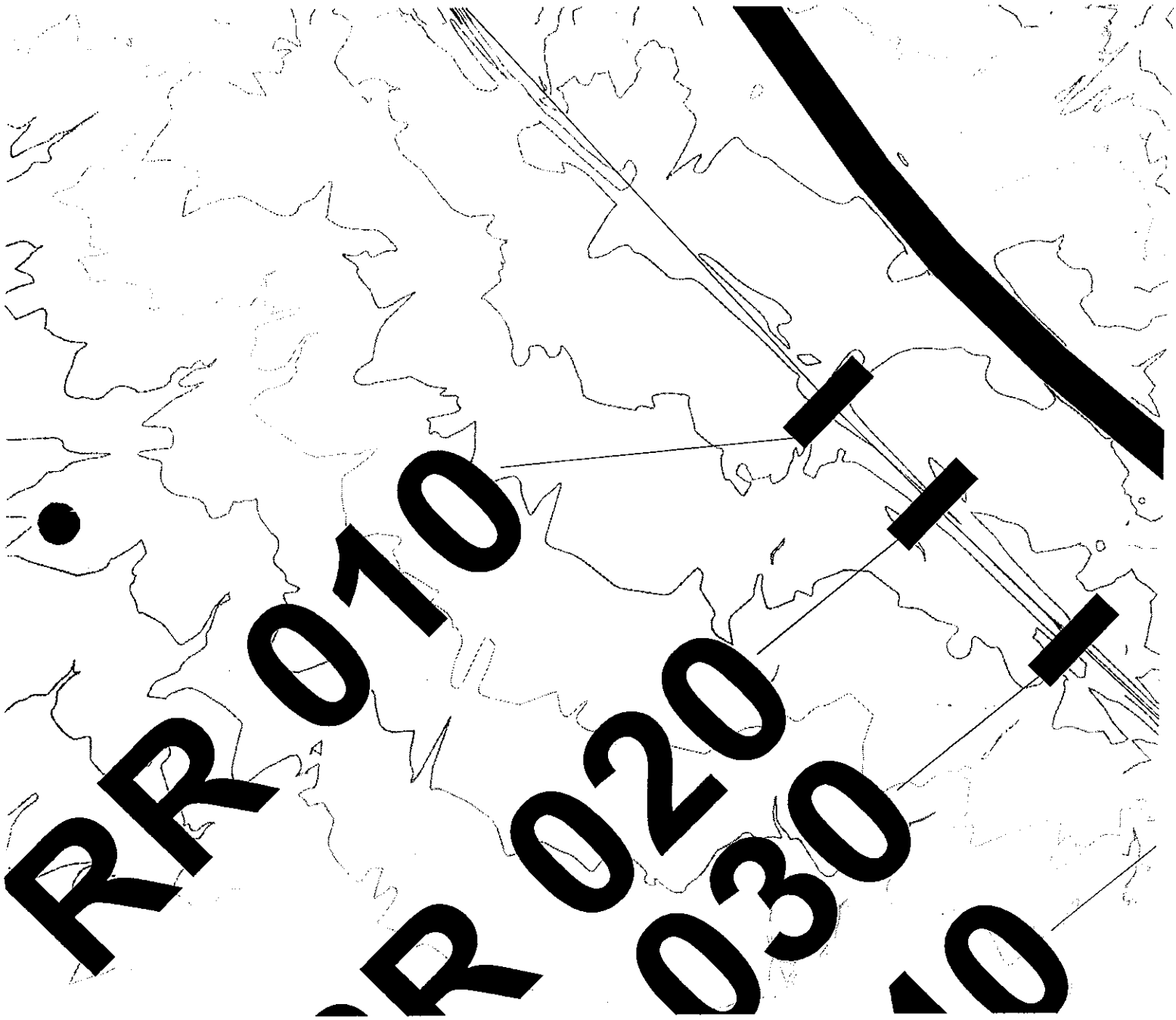
CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

↑N



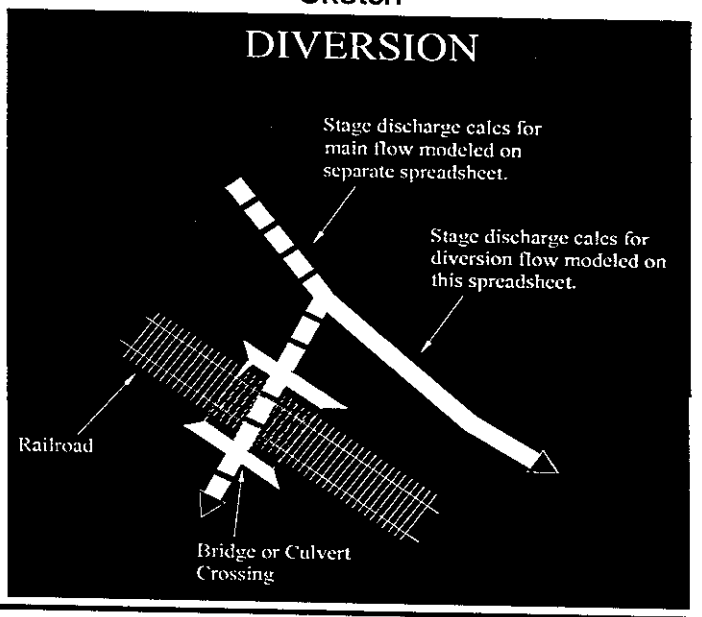
Negligible Storage

Withmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix - D-5-2

Entellus ID RR10 Diversion
Station 148+54
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1968
Upstream Channel Bottom (ft)	1972
Distance between upstream and down (ft)	461
Top Elevation (ft)	1973.4
Top Width (ft)	430
Side Slope, Lt, Z:1	0.01971831
Roughness "n"	0.035
Bottom Width (ft)	288
Bottom Slope, (ft/ft)	0.008677

Sketch



	Stage Elevation*				
	1972	**1972.5**	**1973**	**1973.4**	
Rt Side Slope length (ft)	0.00	0.50	1.00	1.40	
Flow Depth, (ft)	0.00	0.50	1.00	1.40	
X-S Area (sqft)	0.0	144.0	288.0	403.2	
Perimeter, (ft)	288.0	289.0	290.0	290.8	
Hyd. Radius, (ft)	0.00	0.50	0.99	1.39	
Velocity, (fps)	#DIV/0!	2.49	3.95	4.93	
Diversion Discharge (cfs)	**0.0**	**358.9**	**1136.9**	**1988.4**	

* Only 4 Foot Contours Available

Sheet 4 of 4

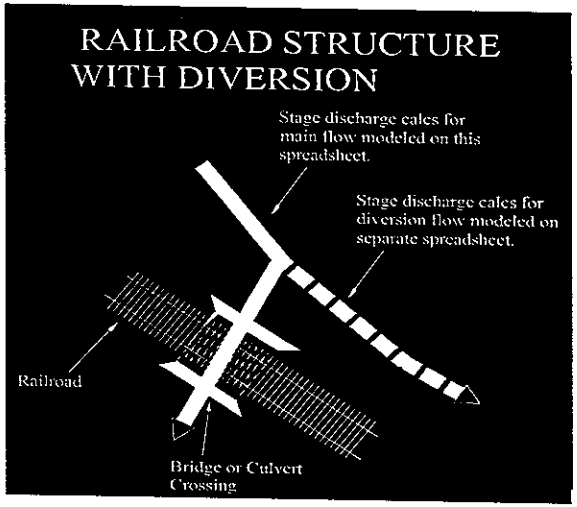
RR40

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D – 2

Entellus ID	RR40	0
Station	150+70	
Description	4 x 3 Box Culvert	

Nomograph Input	
Culvert Invert Elevation (ft)	1962.7
Spilling Stage Elevation (ft)	1964
Width (ft)	4
Height (ft)	3
Number of Boxes	1

Sketch



	Stage Elevation								
	1962.7	**1964**	**1964.5**	**1965**	**1965.5**	**1966**	**1966.5**	**1967**	**1967.5**
Headwater Depth (ft)	0.00	1.30	1.80	2.30	2.80	3.30	3.80	4.30	4.80
Headwater Depth / Height	0.00	0.43	0.60	0.77	0.93	1.10	1.27	1.43	1.60
Ratio of Discharge to Width (cfs/ft)	0.00	3.50	6.00	8.80	12.00	15.00	18.00	21.00	23.00
Discharge (cfs)	0.0	14.0	24.0	35.2	48.0	60.0	72.0	84.0	92.0
Diversion Discharge (cfs)	0.0	0.0	55.2	172.7	334.7	762.9	1302.0	1930.2	2632.4
Total Discharge (cfs)	0.00	14.00	79.21	207.94	382.72	822.94	1374.03	2014.15	2724.40
Storage Area (acres)	0	0	0	0	0	0	0	0	0

WLB flow (cfs) No Similar Concentration Point
Calculated flow at spilling elevation (cfs) 14
Model Diversion? Yes

Sheet 1 of 4

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

CHECK AMG DATE 1/30/01

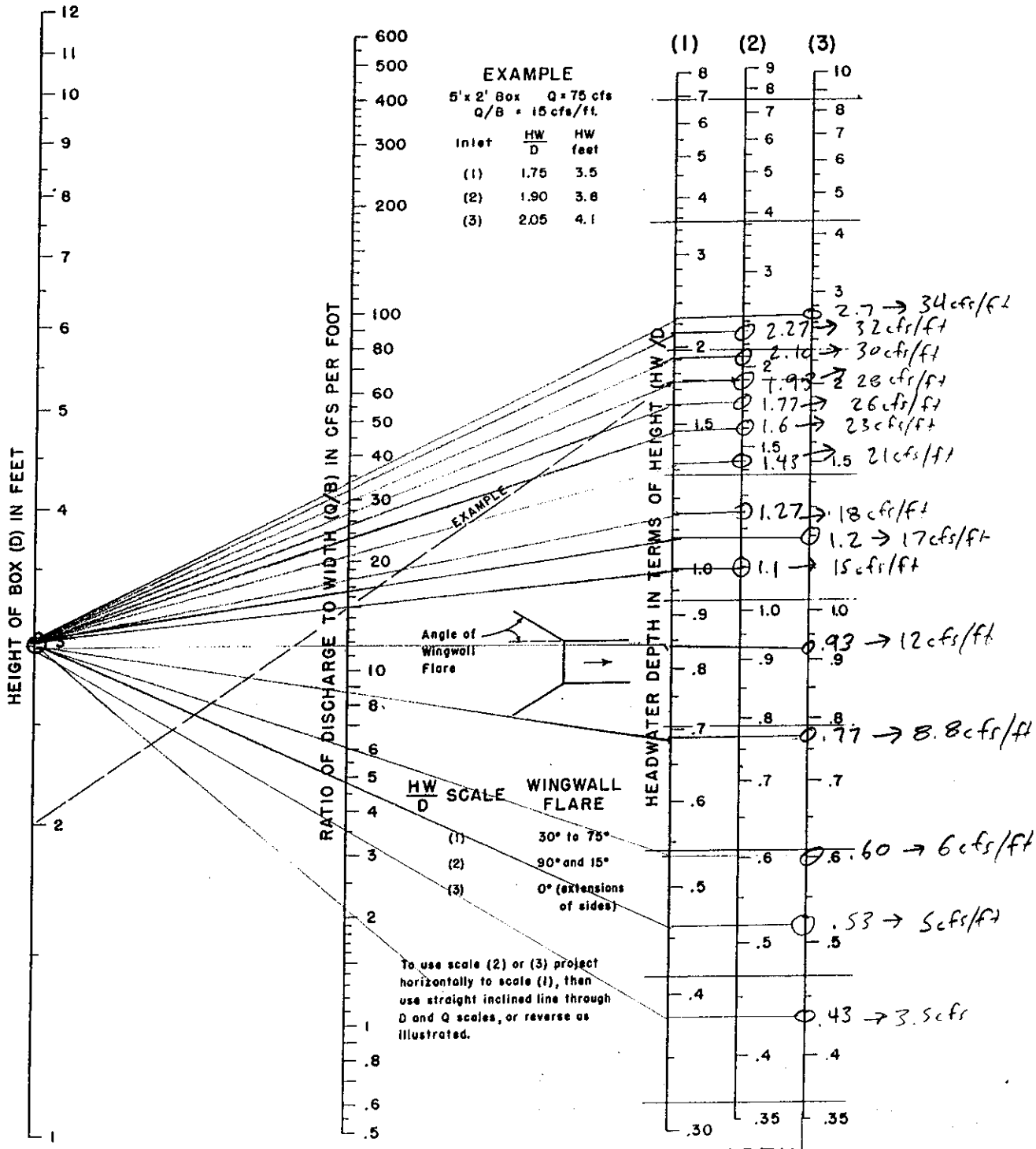
CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 310.0132

Box culvert

RR# 40, 50, 240

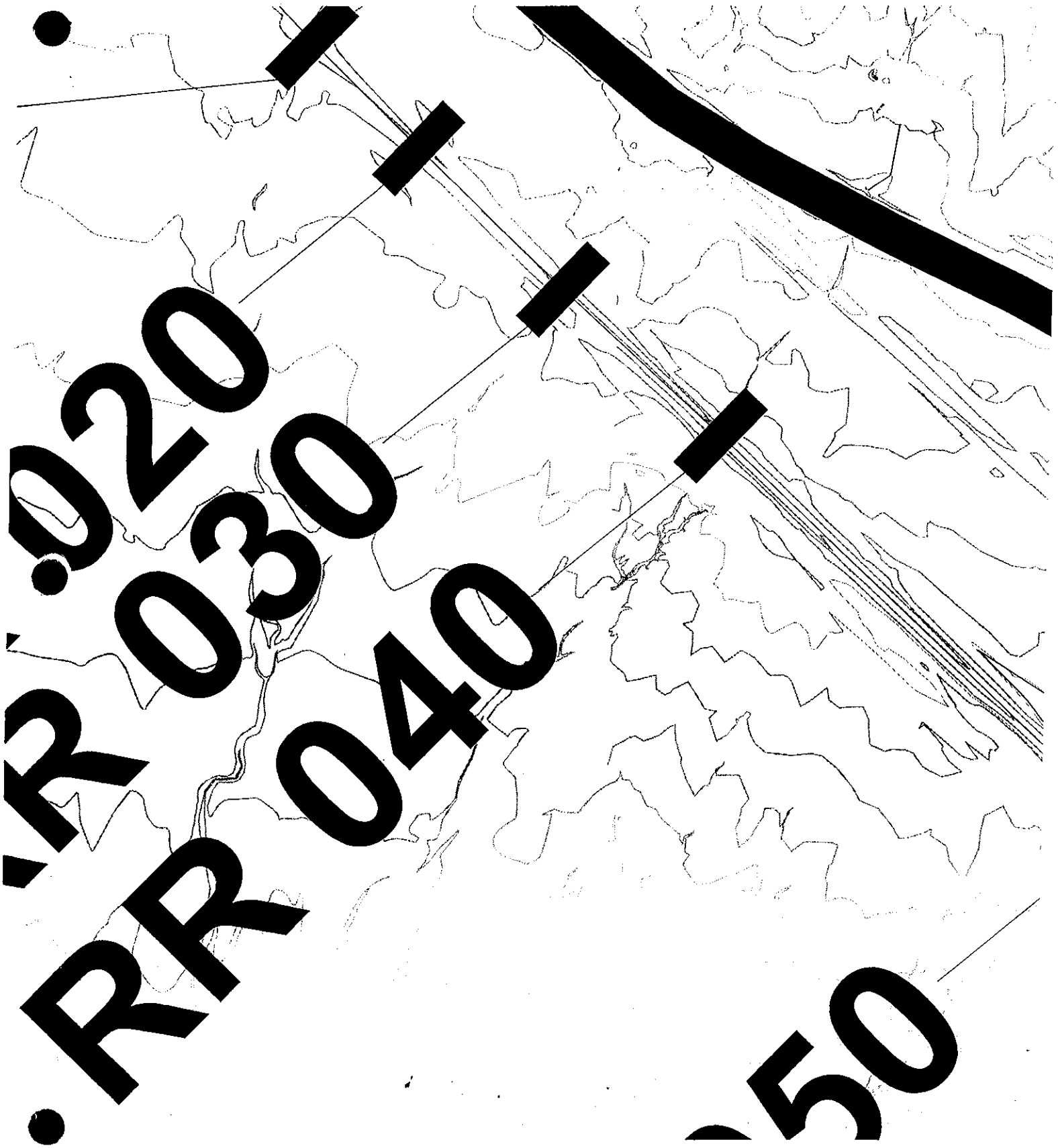
CHART 8



HEADWATER DEPTH FOR BOX ~~CULVERTS~~ WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

↑N



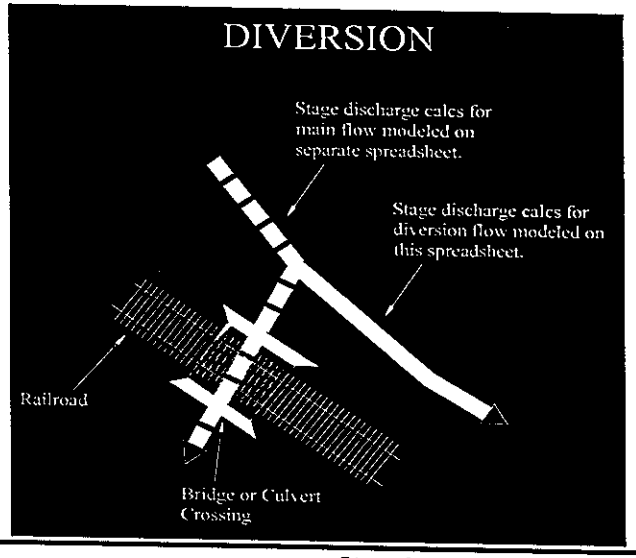
Negligible Storage

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D 5.2

Entellus ID RR40 Diversion
Station 150+70
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1962
Upstream Channel Bottom (ft)	1964
Distance between upstream and down (ft)	202
Top Elevation (ft)	1969.68
Top Width (ft)	147
Side Slope, Lt, Z:1	0.108190476
Roughness "n"	0.035
Bottom Width (ft)	42
Bottom Slope, (ft/ft)	0.009901

Sketch



	Stage Elevation							
	1964	**1964.5**	**1965**	**1965.5**	**1966.5**	**1967.5**	**1968.5**	**1969.5**
Rt Side Slope length (ft)	0.00	0.50	1.01	1.51	2.51	3.52	4.53	5.53
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.50	3.50	4.50	5.50
X-S Area (sqft)	0.0	21.0	42.1	63.2	105.7	148.3	191.2	234.3
Perimeter, (ft)	42.0	43.0	44.0	45.0	47.0	49.0	51.1	53.1
Hyd. Radius, (ft)	0.00	0.49	0.96	1.40	2.25	3.02	3.74	4.41
Velocity, (fps)	#DIV/0!	2.63	4.11	5.31	7.27	8.86	10.22	11.40
Diversion Discharge (cfs)	**0.0**	**55.3**	**173.2**	**336.0**	**768.0**	**1314.0**	**1953.1**	**2670.7**

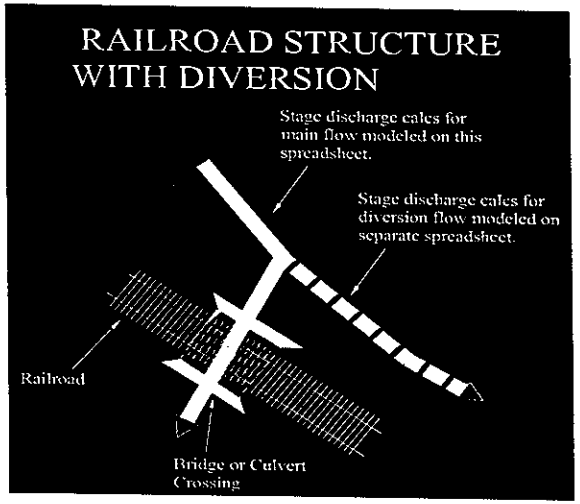
RR50

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix B-5

Entellus ID	RR50	0
Station	151+00	
Description	2 - 4 x 3 Box Culverts	

Nomograph Input	
Culvert Invert Elevation (ft)	1957.3
Spilling Stage Elevation (ft)	1960
Width (ft)	4
Height (ft)	3
Number of Boxes	2

Sketch



	Stage Elevation								
	1957.3	**1958**	**1960**	**1960.5**	**1961**	**1961.5**	**1962**	**1962.5**	**1963**
Headwater Depth (ft)	0.00	0.70	2.70	3.20	3.70	4.20	4.70	5.20	5.70
Headwater Depth / Height	0.00	0.23	0.90	1.07	1.23	1.40	1.57	1.73	1.90
Ratio of Discharge to Width (cfs/ft)	0.00	2.00	12.00	15.00	18.00	21.00	23.00	26.00	28.00
Discharge (cfs)	0.0	16.0	96.0	120.0	144.0	168.0	184.0	208.0	224.0
Diversion Discharge (cfs)	0.0	0.0	0.0	86.9	273.5	533.4	854.8	1230.3	1654.4
Total Discharge (cfs)	0.00	16.00	96.00	206.86	417.55	701.40	1038.81	1438.30	1878.43
Storage Area (acres)	**0**	**0.0762**	**5.2472**	**5.2472**	**5.2472**	**5.2472**	**5.2472**	**5.2472**	**5.2472**

WLB flow (cfs) 332
Calculated flow at spilling elevation (cfs) 96
Model Diversion? Yes

Sheet 1 of 4

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

CHECK AMG DATE 1/30/01

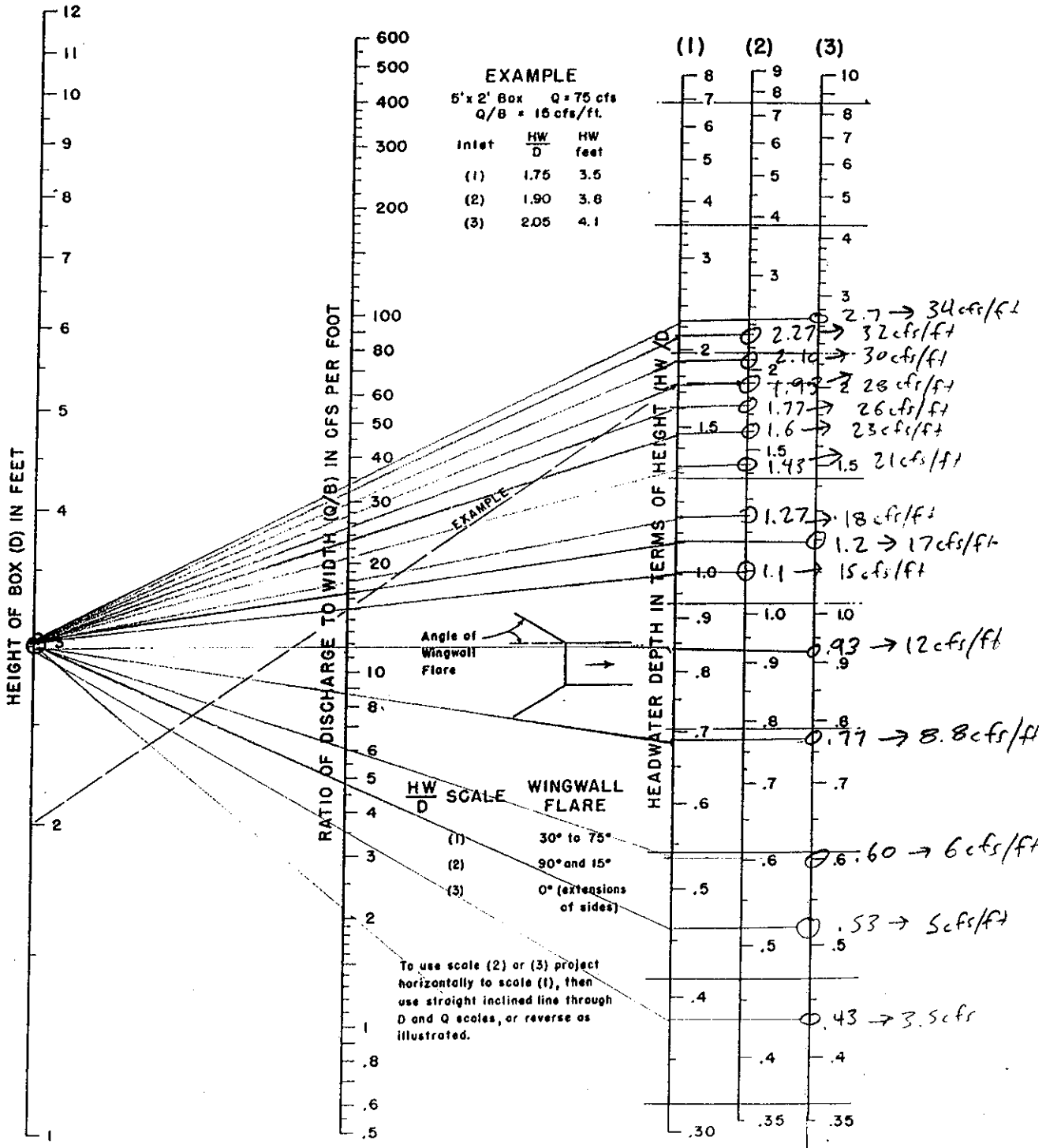
CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 310.0152

Box culvert

RR# 40, 50, 240

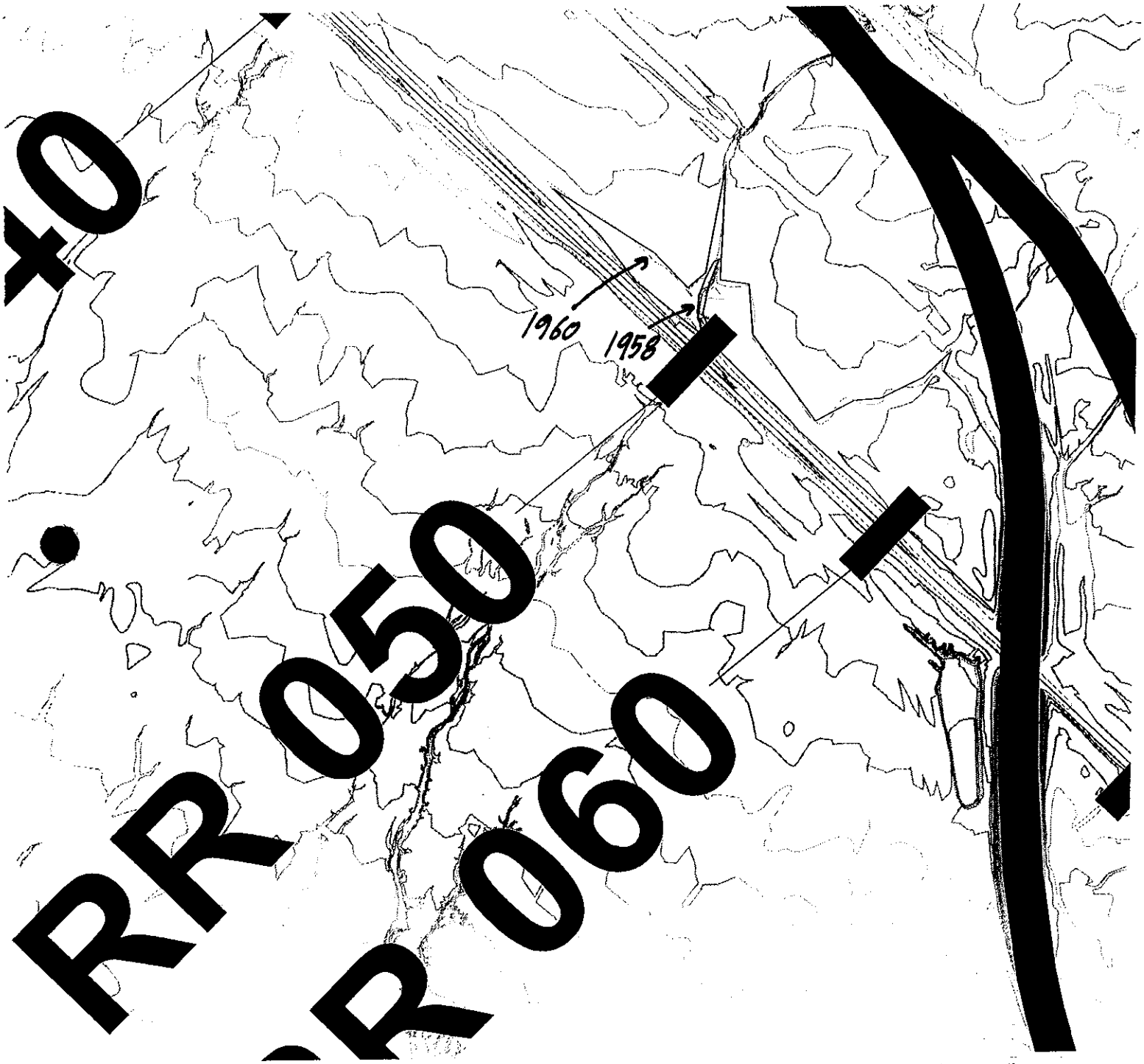
CHART 8



HEADWATER DEPTH FOR BOX ~~CULVERTS~~ WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

↑N



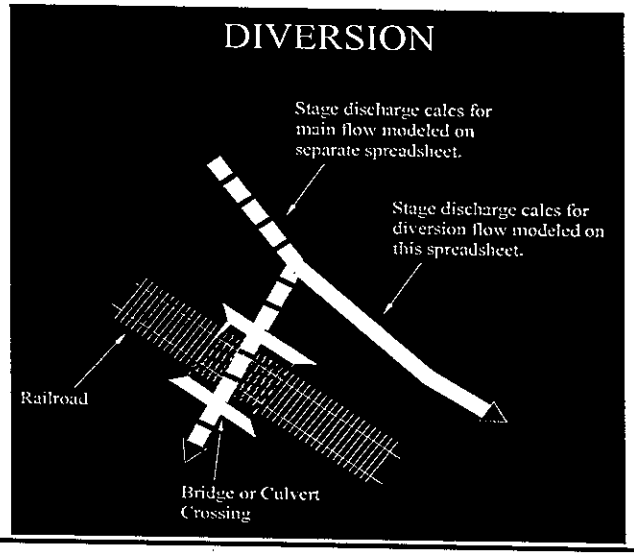
RR 050
RR 060

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix C-5

Entellus ID RR50 Diversion
Station 151+00
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1958
Upstream Channel Bottom (ft)	1960
Distance between upstream and down (ft)	278
Top Elevation (ft)	1962
Top Width (ft)	181
Side Slope, Lt, Z:1	0.038461538
Roughness "n"	0.035
Bottom Width (ft)	77
Bottom Slope, (ft/ft)	0.007194

Sketch



	Stage Elevation							
	1960	**1960.5**	**1961**	**1961.5**	**1962**	**1962.5**	**1963**	**1963.5**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50
X-S Area (sqft)	0.0	38.5	77.0	115.6	154.2	192.7	231.3	270.0
Perimeter, (ft)	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0
Hyd. Radius, (ft)	0.00	0.49	0.98	1.44	1.90	2.35	2.79	3.21
Velocity, (fps)	#DIV/0!	2.26	3.55	4.61	5.55	6.38	7.15	7.86
Diversion Discharge (cfs)	**0.0**	**86.9**	**273.5**	**533.4**	**854.8**	**1230.3**	**1654.4**	**2122.9**

US7, US8, RR90 and RR100

Entellus™

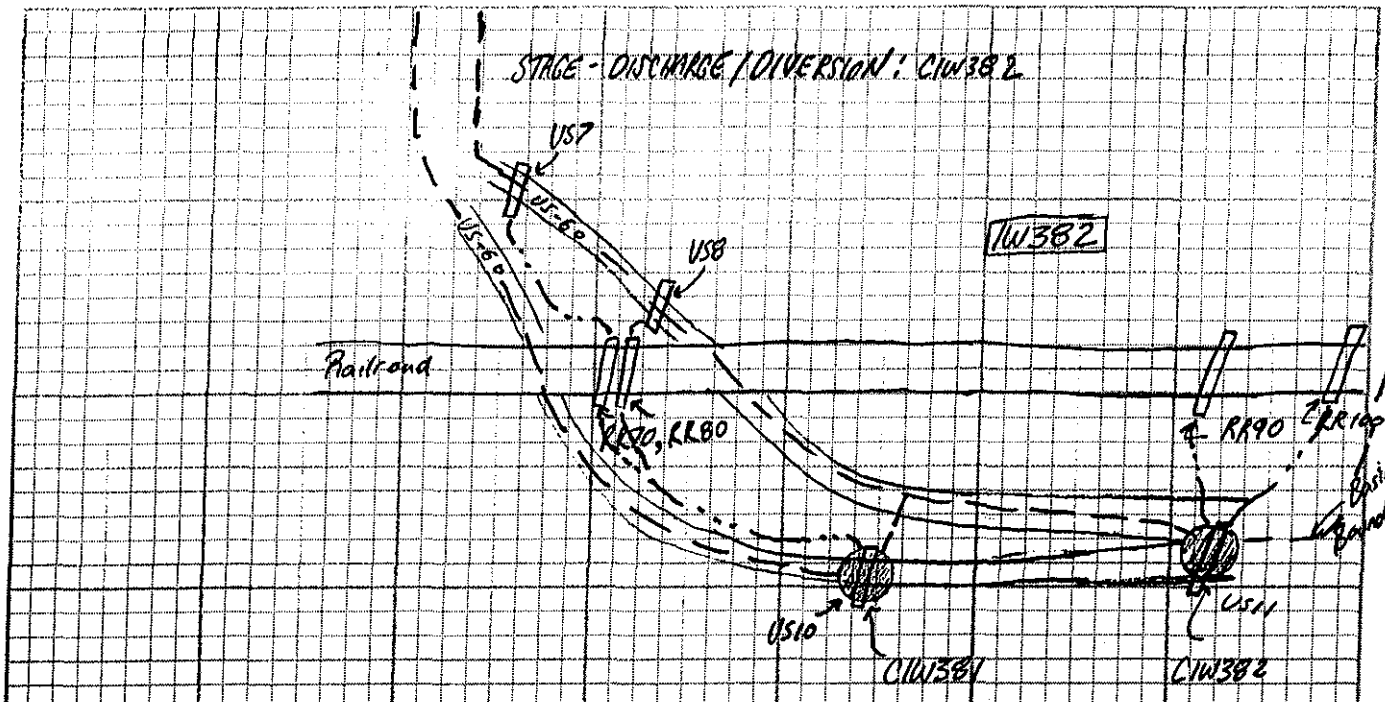
SHEET 1 OF 9

BY JS DATE 4/5/4

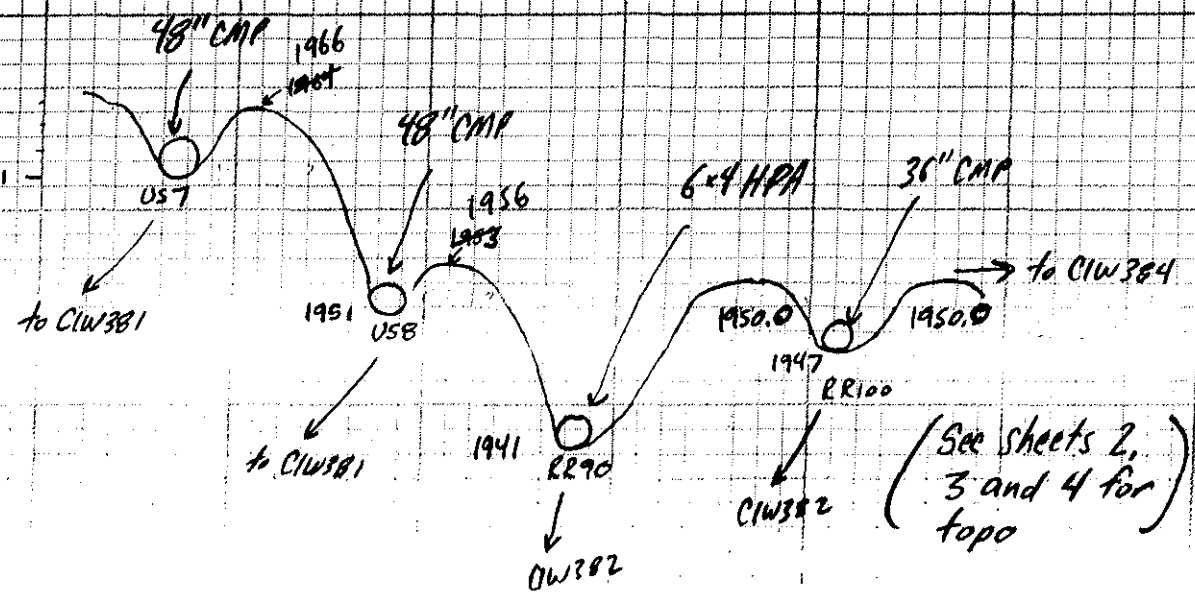
CHECK CJL DATE 4/13/4

CLIENT FCD

JOB NAME Willmann ADMSU JOB NO. 310012

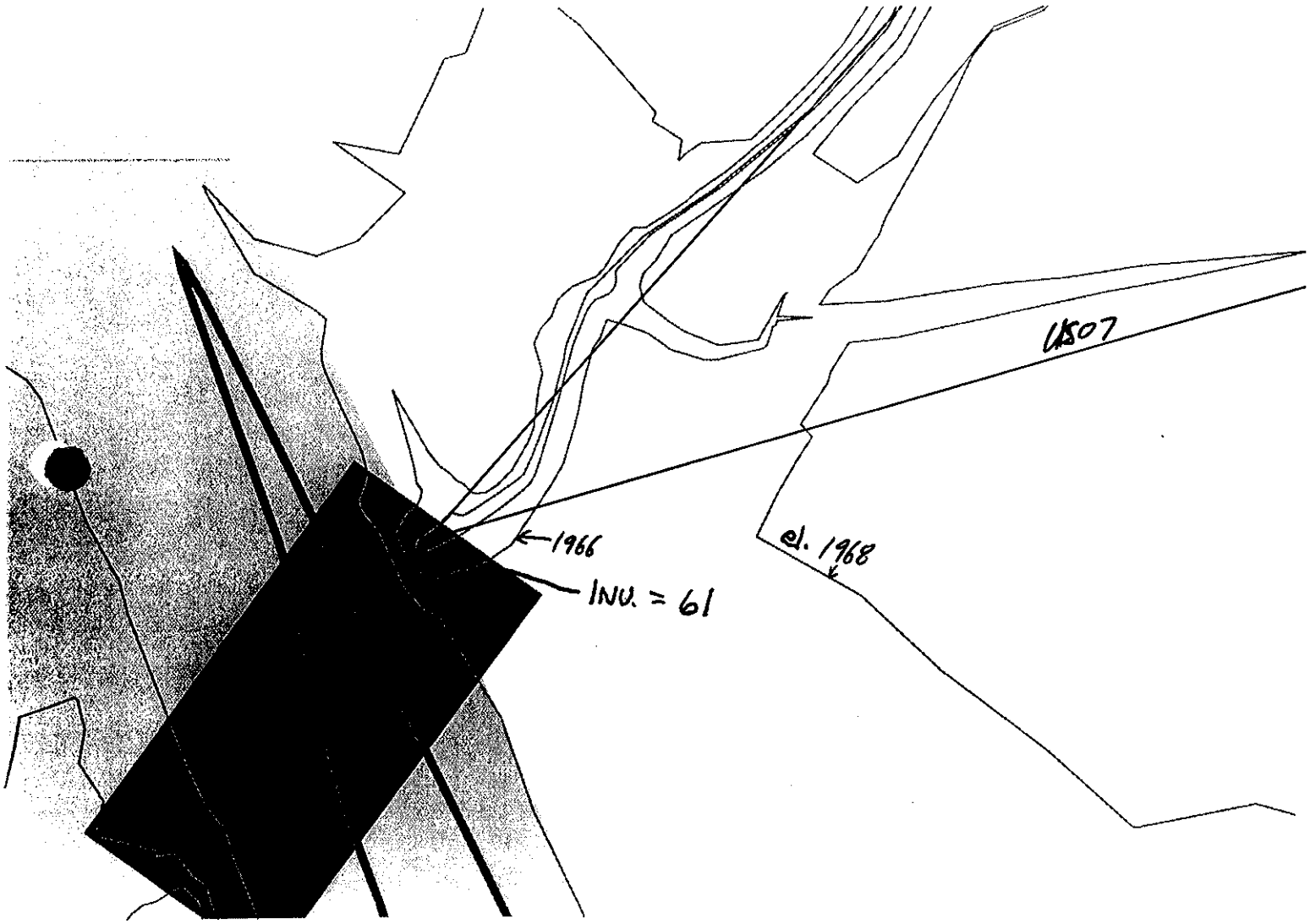


In order to model flow leaving basin IW382 via US7 and US8, a diversion is used from CIW382 to CIW381. This diversion is based on a stage discharge estimation using US7, US8, RR90 and RR100. It has been assumed that RR70 and RR80 have enough capacity to pass the flow from US7 and US8. It has been assumed that US10 has enough capacity to pass flow from RR70 and RR80 without significant attenuation or diversion.

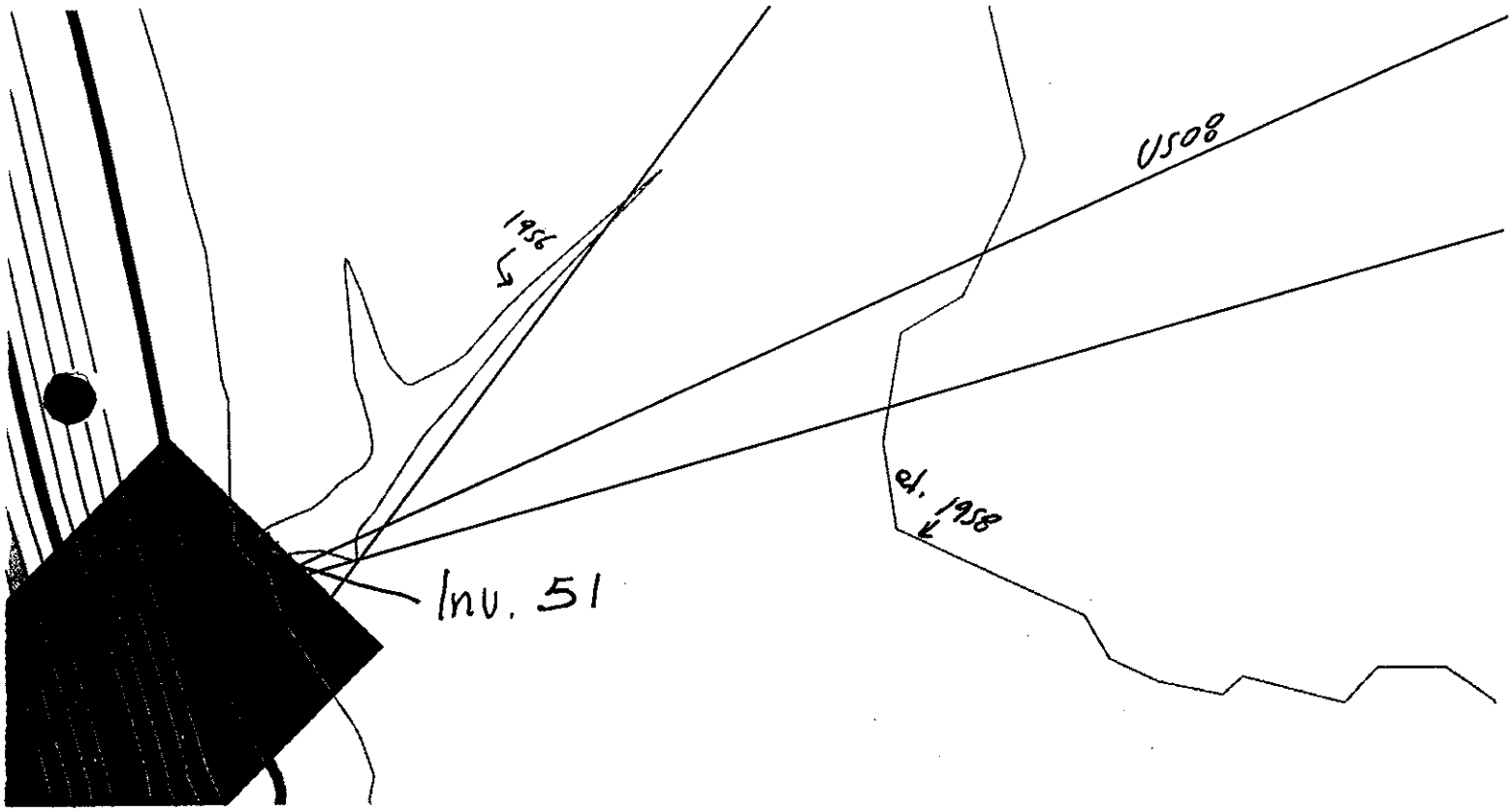


(See sheets 2, 3 and 4 for topo)

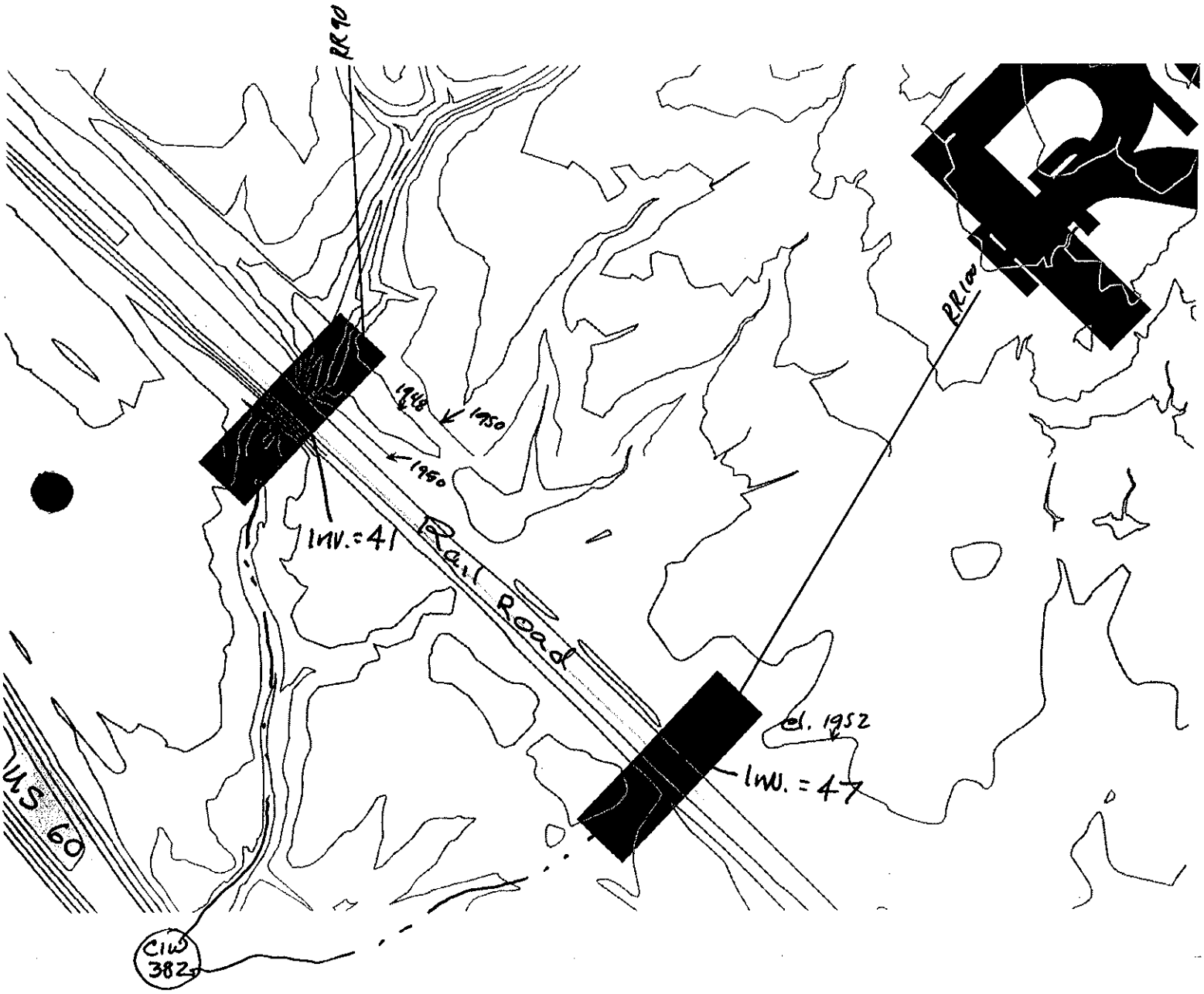
Culv. US07



Culv. U508



Culv. RR 90 + 100



Entellus™

SHEET 5 OF 9

BY JS DATE 4/11/14

CHECK ____ DATE ____

CLIENT FCD

JOB NAME Willmann QDMSU JOB NO. 310052

#1 (to 382 from 381) USO7			#2 USO8			#3 RR90		#4 RR100			#5 Diversion to CIW384	
Q	H/D	E	Q	H/D	E	Q	E	Q	H/D	E	Q	E
24	.5	1963										
47	.75	1964										
85	1.25	1966	0	0	1951							
			0	.25	1952							
			24	.5	1953							
			95	1.25	1956	0	1941					
						14	1942					
						60	1944					
						116	1946					
						168	1948					
						200	1950	0	0	1947		
						200	1950	35	1	1950.5	0	1950
						216	1950.5	44	1.17	1950.5	55	1950.5
						224	1951	50	1.3	1951	174	1951
						236	1951.5	55	1.5	1951.5	338	1951.5
						256	1953	70	2	1953	045	1953
(See sheet 9 for calcs)			(See sheet 9 for calcs)			(See Sheet 6 for calcs)		(See Sheet 9 for calcs)			(See Sheet 7 for calcs)	

Diversion from 382 → 381

DI	24	47	85	109	180 (max. diversion)	10,000	
DQ	24	47	85	109	180	180	

= #1 + #2 (diversion to 381)

Diversion from 382 → 384

DI	14	60	200	315	448	629	1371
DQ	0	0	0	55	174	338	1045

= #5 (diversion to CIW384)

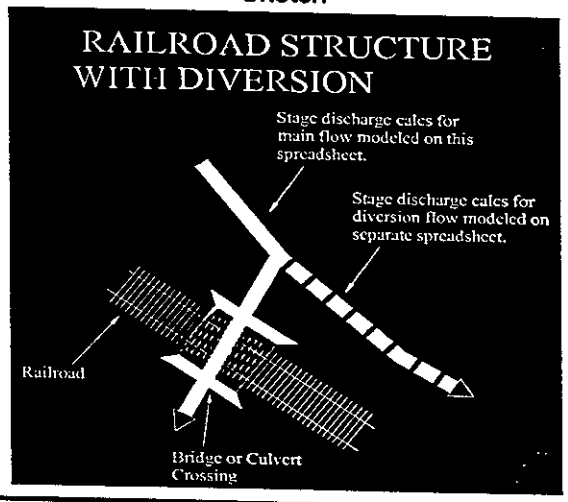
- #2 + #4 + #6 (total inflow)

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entelius ID	RR90	0
Station	151+64	
Description	4' x 6' High Profile Arch	

Nomograph Input	
Culvert Invert Elevation (ft)	1940.8
Spilling Stage Elevation (ft)	1950
Height (ft)	6
Width (ft)	4
Adjusted Height (ft)	4.5

Sketch



	Stage Elevation									
	1940.8	1942	1944	1946	1948	1950	1950.5	1951	1951.5	1953
Headwater Depth (ft)	0.00	1.20	3.20	5.20	7.20	9.20	9.70	10.20	10.70	12.20
Headwater Depth / Height	0.00	0.27	0.71	1.16	1.60	2.04	2.16	2.27	2.38	2.71
Ratio of Discharge to Width (cfs/ft)	0.00	3.50	15.00	29.00	42.00	50.00	54.00	56.00	59.00	64.00
Discharge (cfs)	0.0	14.0	60.0	116.0	168.0	200.0	216.0	224.0	236.0	256.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	55.2	173.5	338.0	1045.0
Discharge from RR100 (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	28.0	50.0	55.0	70.0
Total Discharge (cfs)	0.00	14.00	60.00	116.00	168.00	200.00	299.15	447.51	629.02	1371.00
Storage Area (acres)	0	0.0081	0.1302	0.4087	1.1665	3.5647	3.5647	3.5647	3.5647	3.5647

(See Attached Calc Sheets for RR100 Data)

WLB flow (cfs) No Similar Concentration Point
Calculated flow at spilling elevation (cfs) 200
Model Diversion? Yes

See sheet 7 for calcs

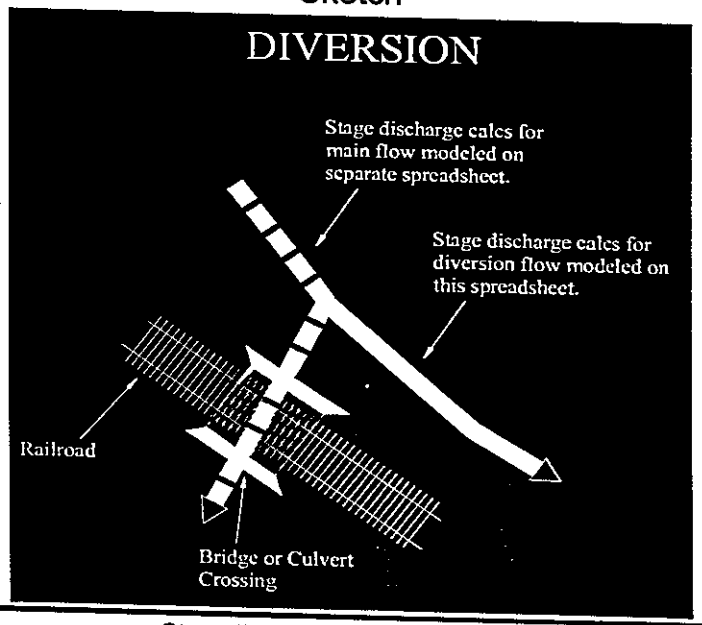
See sheet 8 for nomogram.

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR90 Diversion
Station 151+64
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1948
Upstream Channel Bottom (ft)	1950
Distance between upstream and down (ft)	521
Top Elevation (ft)	1952
Top Width (ft)	142 0.05
Side Slope, Lt, Z:1	0.053333333
Roughness "n"	0.035
Bottom Width (ft)	67
Bottom Slope, (ft/ft)	0.003839 0.004

Sketch



	Stage Elevation					
	1950	**1950.5**	**1951**	**1951.5**	**1952**	**1953**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00	3.00
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00	3.00
X-S Area (sqft)	0.0	33.5	67.1	100.6	134.2	201.5
Perimeter, (ft)	67.0	68.0	69.0	70.0	71.0	73.0
Hyd. Radius, (ft)	0.00	0.49	0.97	1.44	1.89	2.76
Velocity, (fps)	#DIV/0!	1.65	2.59	3.36	4.03	5.19
Diversion Discharge (cfs)	**0.0**	**55.2**	**173.5**	**338.0**	**541.2**	**1045.6**

Entellus™

SHEET 8 OF 9

BY [illegible] DATE

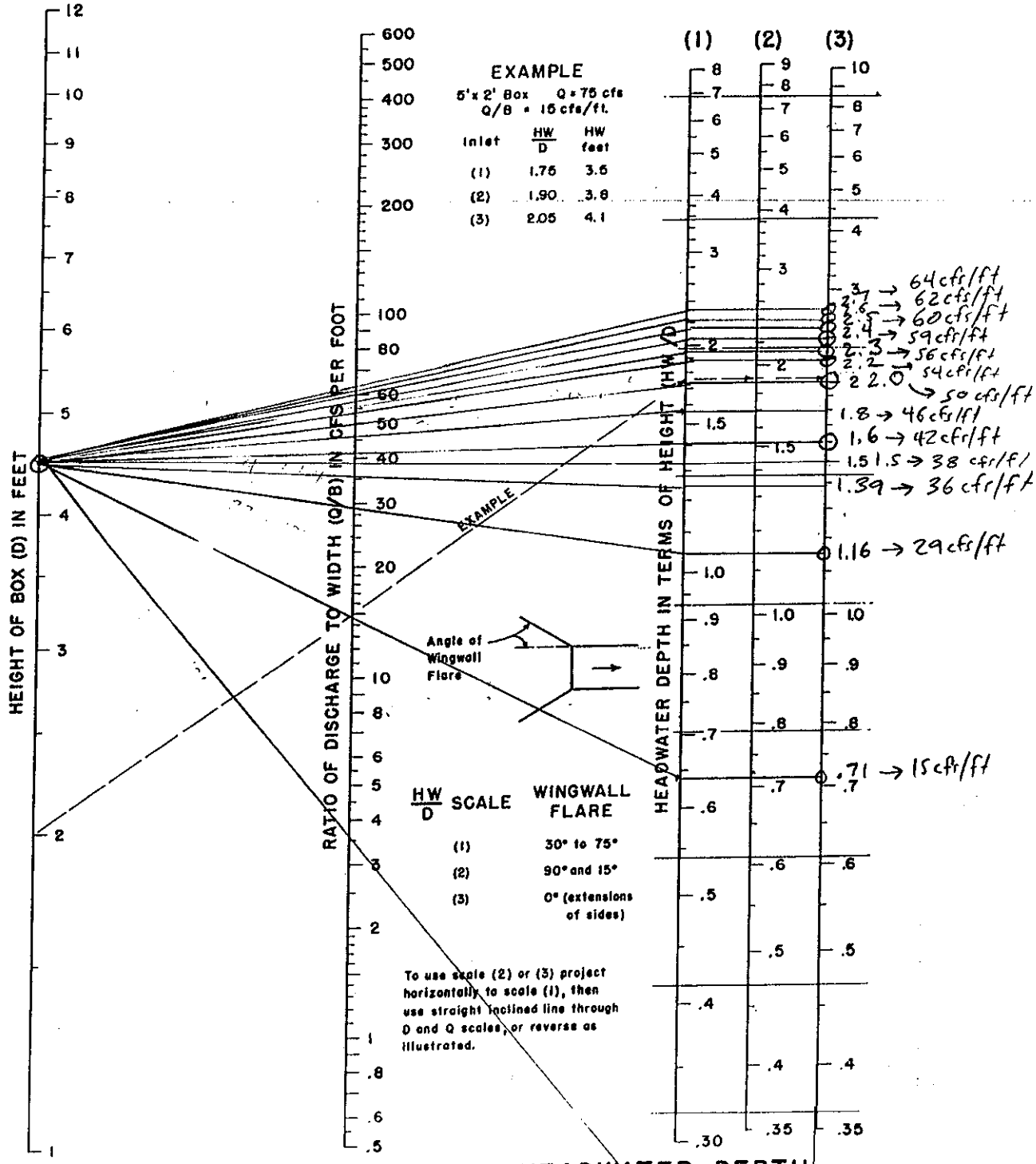
CHECK AMG DATE 1/20/11

CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 3100182

HPA modeled as Box culvert
RR# 90, 170 : 6' High Profile Arch modeled as 4.5' Box.

CHART 8

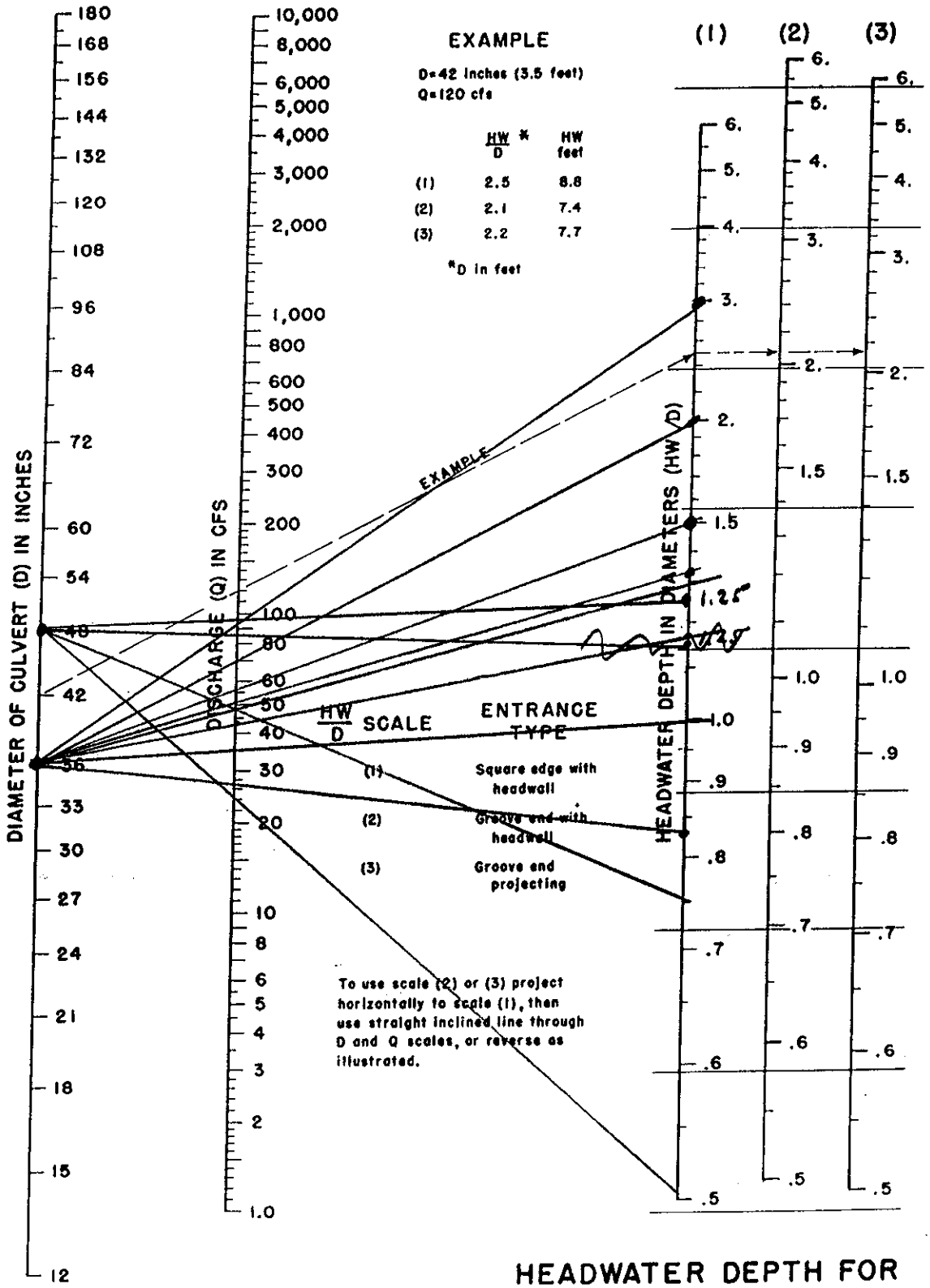


HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

US7, US8, RR100

CHART 1



HEADWATER SCALES 2&3
REVISED MAY 1964

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

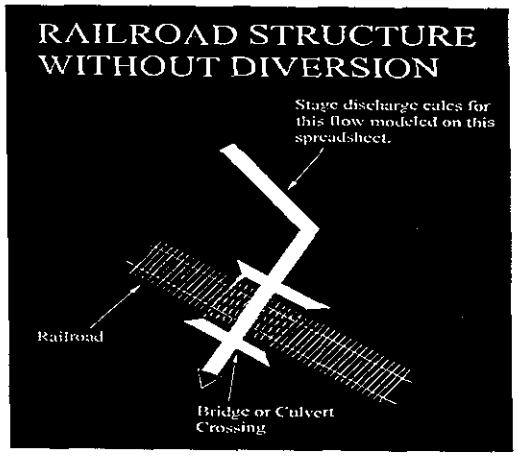
RR140

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID	RR140
Station	152+37
Description	13' x 8' Wooden Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1926
Downstream Channel Invert Elevation (ft)	1924
Bridge Invert Elevation (ft)	1926.1
Downstream Station (ft)	62
Spilling Stage Elevation (ft)	1930
Average Space Between Pilings (ft)	13
Number of Pilings (ft)	8
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	0
Side Slope, Lt, Z:1	0
Roughness "n"	0.035
Bottom Width (ft)	117
Clogging Factor (ft)	12
Adjusted Bottom Width (ft)	105
Bottom Slope, (ft/ft)	0.032258

Sketch



	Stage Elevation				
	1926.1	**1928**	**1930**	**1930.5**	**1931**
Rt Side Slope length (ft)	0.00	1.90	3.90	4.40	4.90
Lt Side Slope length (ft)	0.00	1.90	3.90	4.40	4.90
Flow Depth, (ft)	0.00	1.90	3.90	4.40	4.90
X-S Area (sqft)	0.0	199.5	409.5	462.0	514.5
Perimeter, (ft)	105.0	108.8	112.8	113.8	114.8
Hyd. Radius, (ft)	0.00	1.83	3.63	4.06	4.48
Velocity, (fps)	#DIV/0!	11.45	18.06	19.46	20.78
Discharge (cfs)	**0.0**	**2285.2**	**7395.8**	**8989.7**	**10693.5**
Storage Area (acres)	**0.1396**	**0.7557**	**1.9280**	**1.928**	**1.928**

WLB flow (cfs) 2371
Calculated flow at spilling elevation (cfs) 7395
Model Diversion? No

Sheet 1 of 7

N
130
140
RR
RR
RR
1930
1928
1926.1

RR170

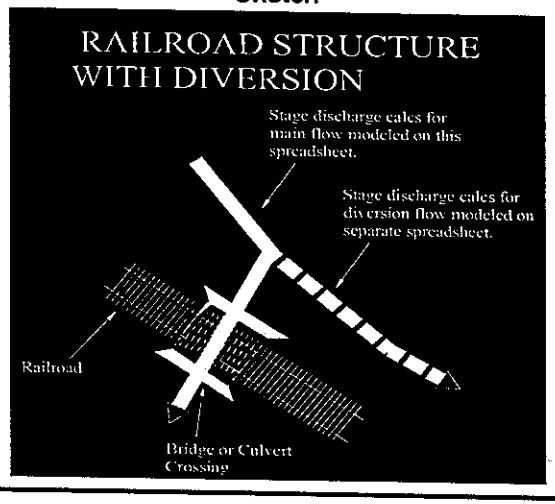
Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D.5.2

Entelius ID RR170 0
Station 153+00
Description 4' x 6' High Profile Arch

Nomograph Input

Culvert Invert Elevation (ft)	1898.8
Spilling Stage Elevation (ft)	1910
Height (ft)	6
Width (ft)	4
Adjusted Height (ft)	4.5

Sketch



	Stage Elevation										
	1898.8	**1900**	**1902**	**1904**	**1906**	**1908**	**1910**	**1910.5**	**1911**	**1911.5**	**1912**
Headwater Depth (ft)	0.00	1.20	3.20	5.20	7.20	9.20	11.20	11.70	12.20	12.70	13.20
Headwater Depth / Height	0.00	0.27	0.71	1.16	1.60	2.04	2.49	2.60	2.71	2.82	2.93
Ratio of Discharge to Width (cfs/ft)	0.00	3.50	15.00	29.00	42.00	50.00	60.00	62.00	64.00	65.00	66.00
Discharge (cfs)	0.0	14.0	60.0	116.0	168.0	200.0	240.0	248.0	256.0	260.0	264.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.5	126.0	243.0508	385.563
Total Discharge (cfs)	0.00	14.00	60.00	116.00	168.00	200.00	240.00	288.46	381.98	503.05	649.56
Storage Area (acres)	**0**	**0.0045**	**0.1398**	**0.5281**	**1.3309**	**2.2891**	**3.717**	**3.717**	**3.717**	**3.717**	**3.717**

WLB flow (cfs) 435
Calculated flow at spilling elevation (cfs) 240
Model Diversion? Yes

Sheet 1 of 4

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

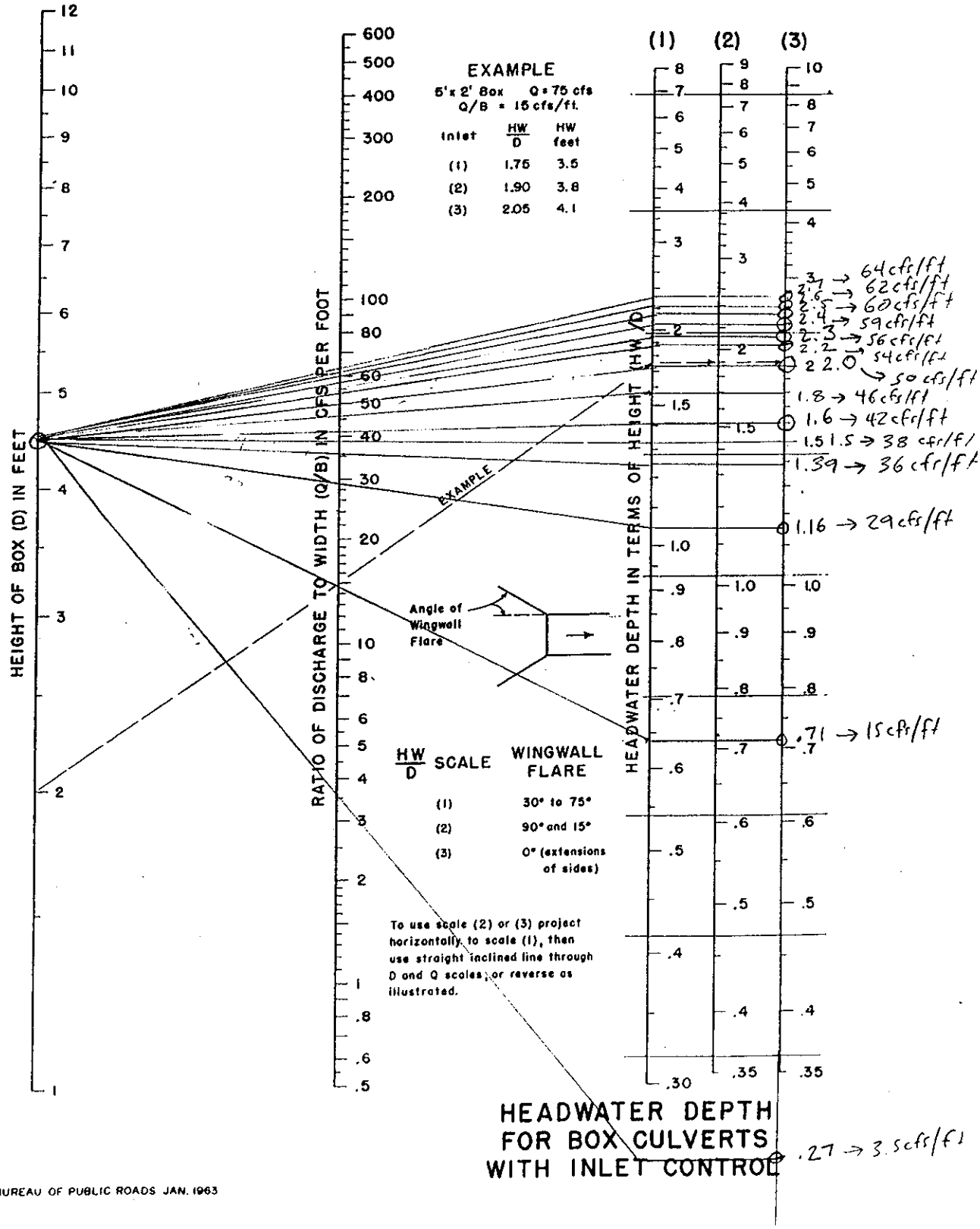
CHECK MLG DATE 1/30/04

CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 310.0132

HPA modeled as Box culvert
RR# 90, 170 : 6' High Profile Arch modeled as 4.5' Box.

CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

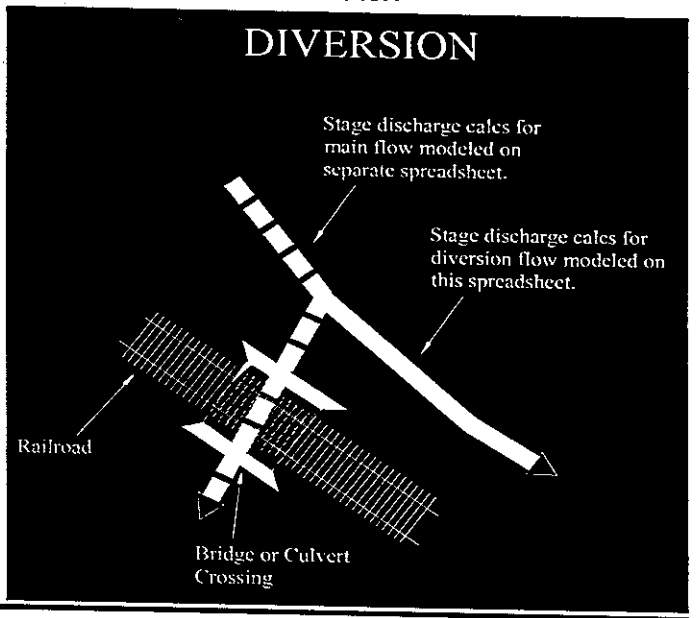
RR170 RR RR

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5-2

Entellus ID RR170 Diversion
Station 153+00
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1908
Upstream Channel Bottom (ft)	1910
Distance between upstream and down (ft)	190
Top Elevation (ft)	1912
Top Width (ft)	88
Side Slope, Lt, Z:1	0.068965517
Roughness "n"	0.035
Bottom Width (ft)	30
Bottom Slope, (ft/ft)	0.010526

Sketch



	Stage Elevation				
	1910	**1910.5**	**1911**	**1911.5**	**1912**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	15.0	30.1	45.2	60.3
Perimeter, (ft)	30.0	31.0	32.0	33.0	34.0
Hyd. Radius, (ft)	0.00	0.48	0.94	1.37	1.77
Velocity, (fps)	#DIV/0!	2.69	4.19	5.38	6.40
Diversion Discharge (cfs)	**0.0**	**40.5**	**126.0**	**243.1**	**385.6**

Sheet 4 of 4

RR190, RR200

Entellus™

SHEET 1 OF 7

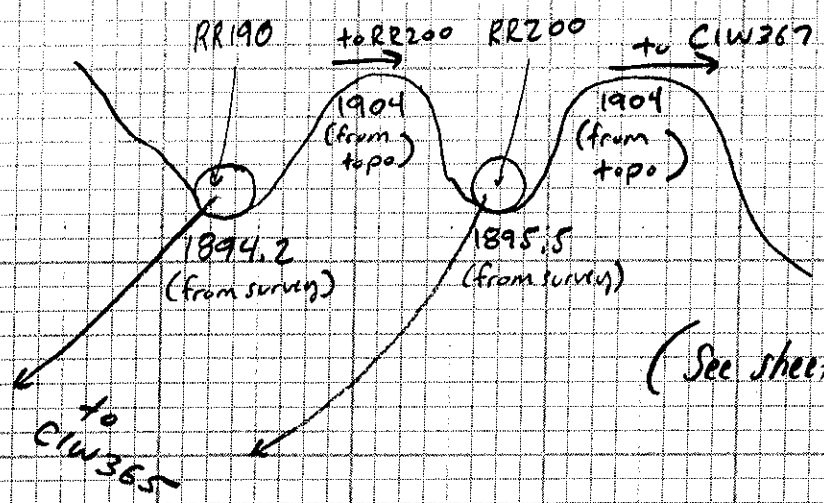
BY JS DATE

CHECK CS DATE 4/15/4

CLIENT FCD

JOB NAME Wittmann ADMSC JOB NO. 310032

DIVERSION FROM CIW365 → CIW367



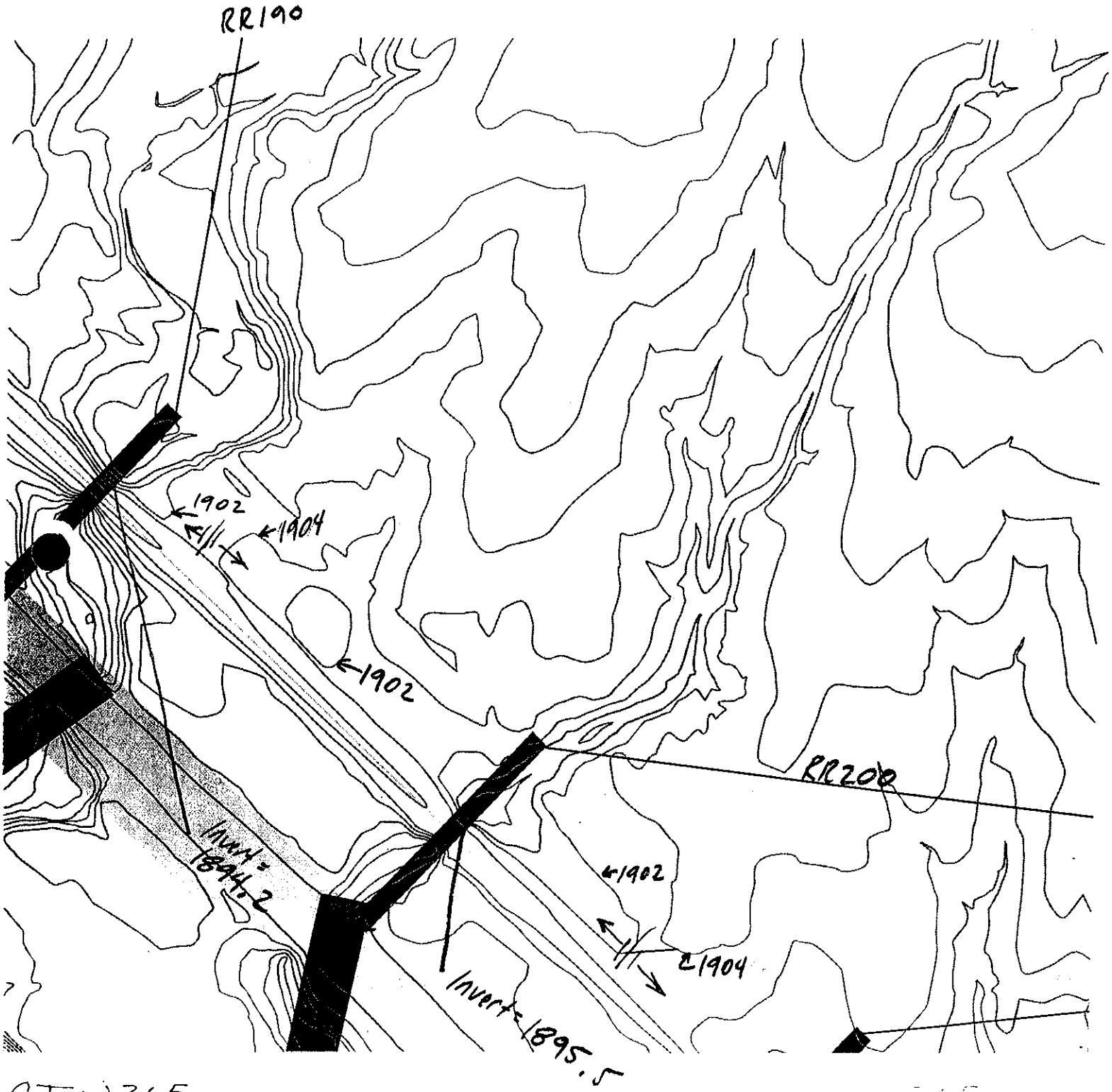
(See sheet 2 for topo)

RR190: 3' x 5' RCB
RR200: 46" RCP = 3.83'

It has been assumed that RR190 and RR200 both fill to 1904 ft, before any diversion to CIW367.

STAGE	#1) RR190 Q	#2) RR200 HW/D, Q	#3) DIVERSION TO CIW367 Q	(#1+#2+#3) DI	(#3) DR
1894.2	0	–	0	0	0
1898	55.5	–	0	–	–
1900	90	–	0	–	–
1902	117	1.7, 120	0	237	0
1904	141	2.2, 140	0	281	0
1904.5	144	2.3, 150	141	435	141
1905	150	2.4, 160	443	753	443
1905.5	153	2.6, 160	865	1178	865
1906	156	2.7, 170	1386	1712	1386

See Sheet 3 See Sheet 5 See Sheet 6



CIW365

CIW367

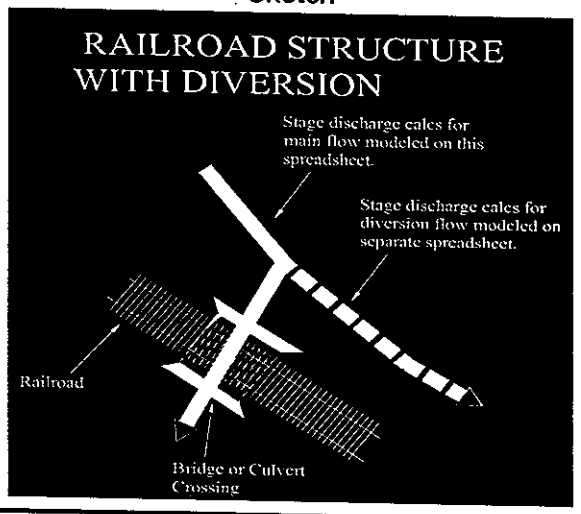
Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5

Entellus ID RR190
Station 153+17
Description 3' x 5' High Profile Arch

Nomograph Input

Culvert Invert Elevation (ft)	1894.2
Spilling Stage Elevation (ft)	1904
Height (ft)	5
Width (ft)	3
Adjusted Height (ft)	3.75

Sketch



	Stage Elevation								
	1894.2	**1898**	**1900**	**1902**	**1904**	**1904.5**	**1905**	**1905.5**	**1906**
Headwater Depth (ft)	0.00	3.80	5.80	7.80	9.80	10.30	10.80	11.30	11.80
Headwater Depth / Height	0.00	1.01	1.55	2.08	2.61	2.75	2.88	3.01	3.15
Ratio of Discharge to Width (cfs/ft)	0.00	18.50	30.00	39.00	47.00	48.00	50.00	51.00	52.00
RR190 Discharge (cfs)	0.0	55.5	90.0	117.0	141.0	144.0	150.0	153.0	156.0
(to CIW367 from RR200) Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	0.0	140.8	443.4	864.7	1385.9
Total Discharge (cfs)	0.00	55.50	90.00	117.00	141.00	284.78	593.39	1017.70	1541.94
Storage Area (acres)	**0**	**0.0966**	**0.4323**	**0.9616**	**1.917**	**1.917**	**1.917**	**1.917**	**1.917**

See Sheet 4 for calcs

See sheet 7, storage not included in HEC-1 model

WLB flow (cfs) No Similar Concentration Point
Calculated flow at spilling elevation (cfs) 141
Model Diversion? Yes

Entellus™

SHEET Sheet 4 OF 7

BY _____ DATE _____

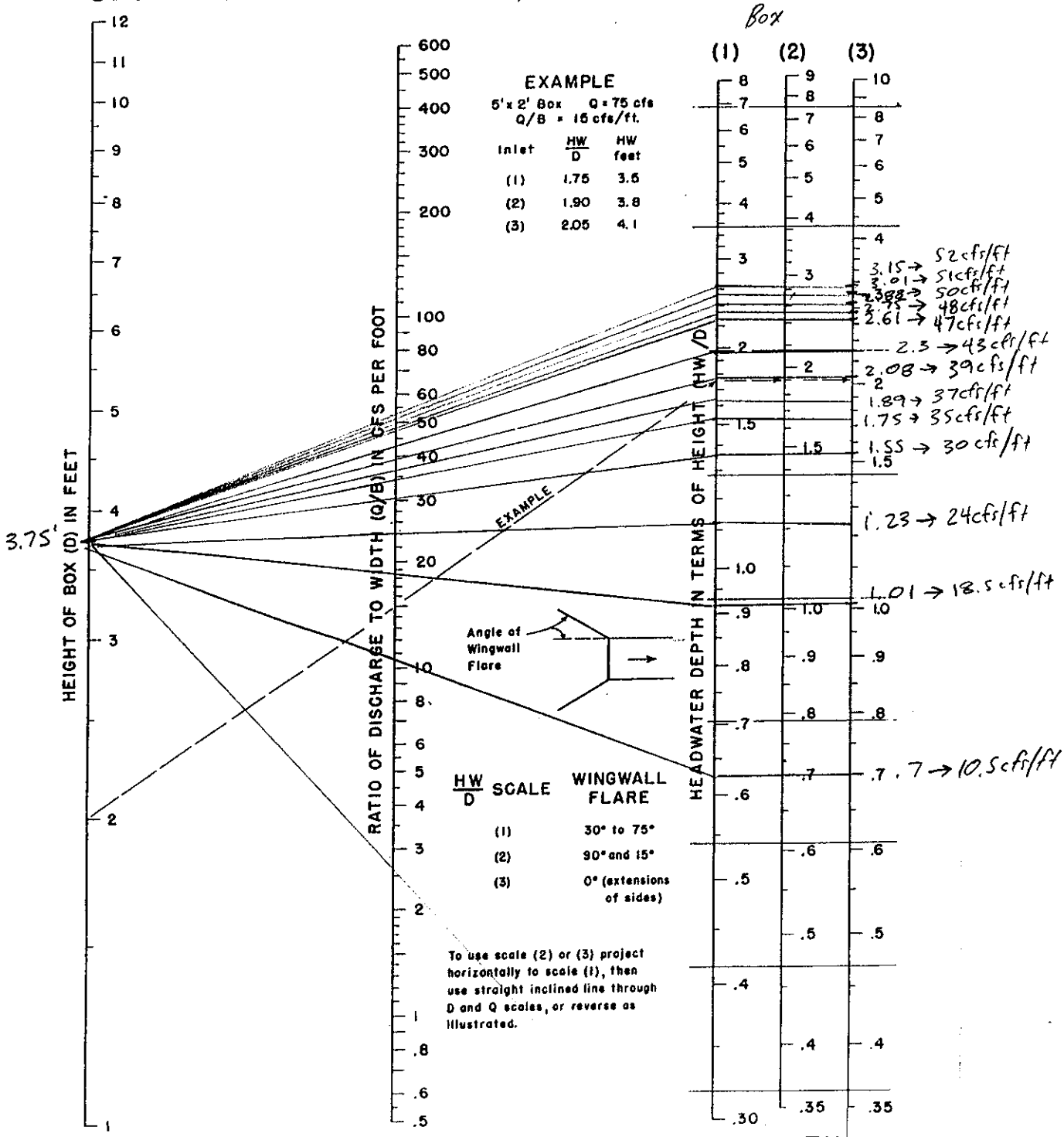
CHECK AWG DATE 1/30/04

CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 310.0182

HPA modeled as Box culvert
RR# 190, 270, 340, 410 : 5' High Profile Arch modeled as 3.7 Box

CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Entellus™

RR200

SHEET 5 OF 7

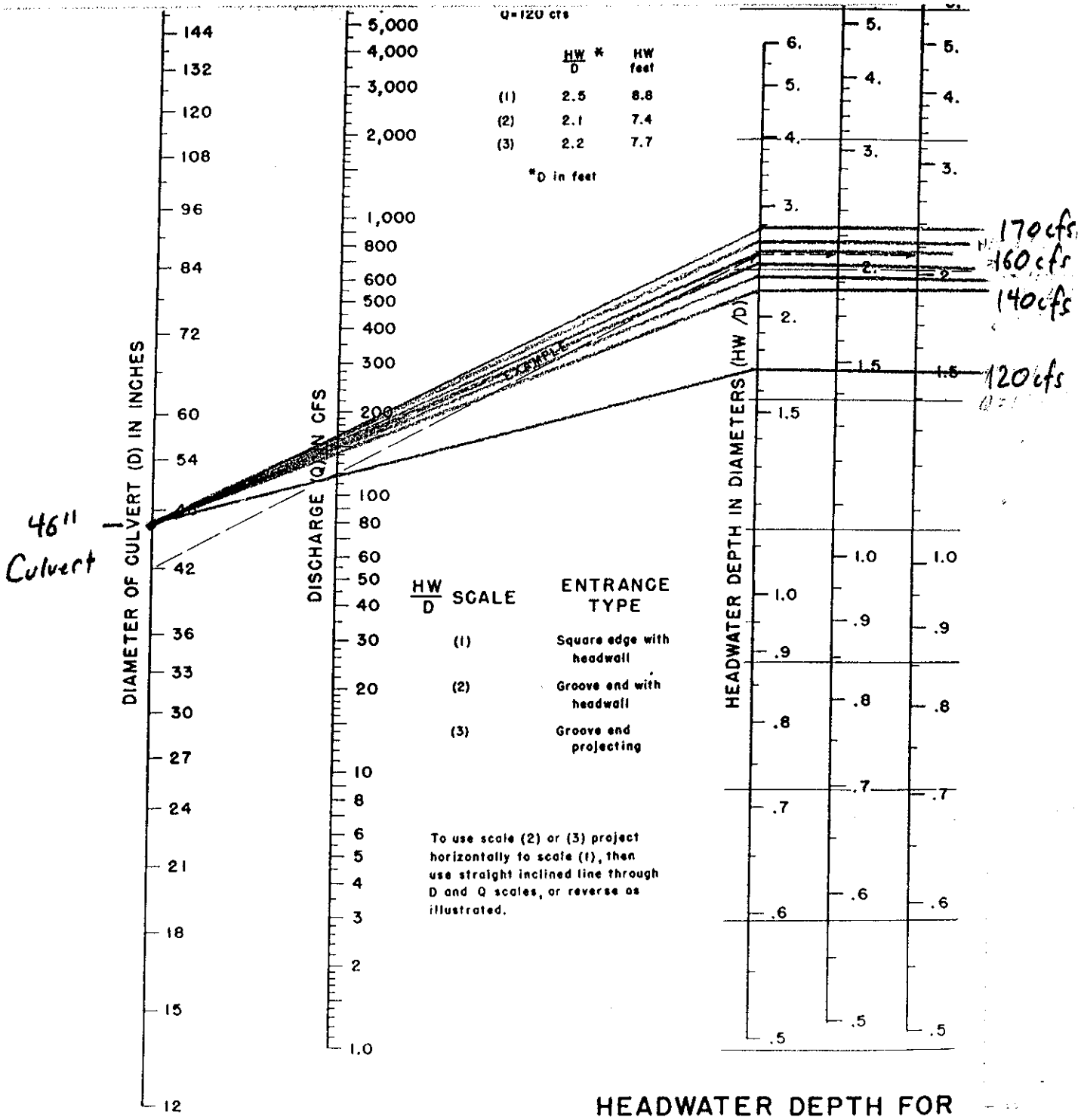
BY JS DATE 4/15/4

CHECK ____ DATE ____

CLIENT FCD

JOB NAME Wittmann DOMSU

JOB NO. ____



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

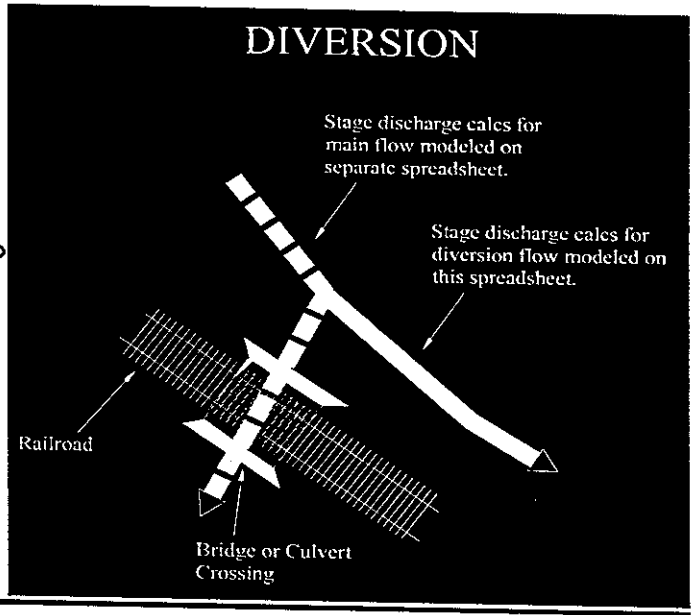
HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix C-5

Entellus ID ~~RR190 Diversion~~ RR200 DIVERSION
Station 153+17
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1902
Upstream Channel Bottom (ft)	1904
Distance between upstream and down (ft)	85
Top Elevation (ft)	1906
Top Width (ft)	100 0.13
Side Slope, Lt, Z:1	0.129032258
Roughness "n"	0.035
Bottom Width (ft)	69
Bottom Slope, (ft/ft)	0.023529 0.0235

Notes

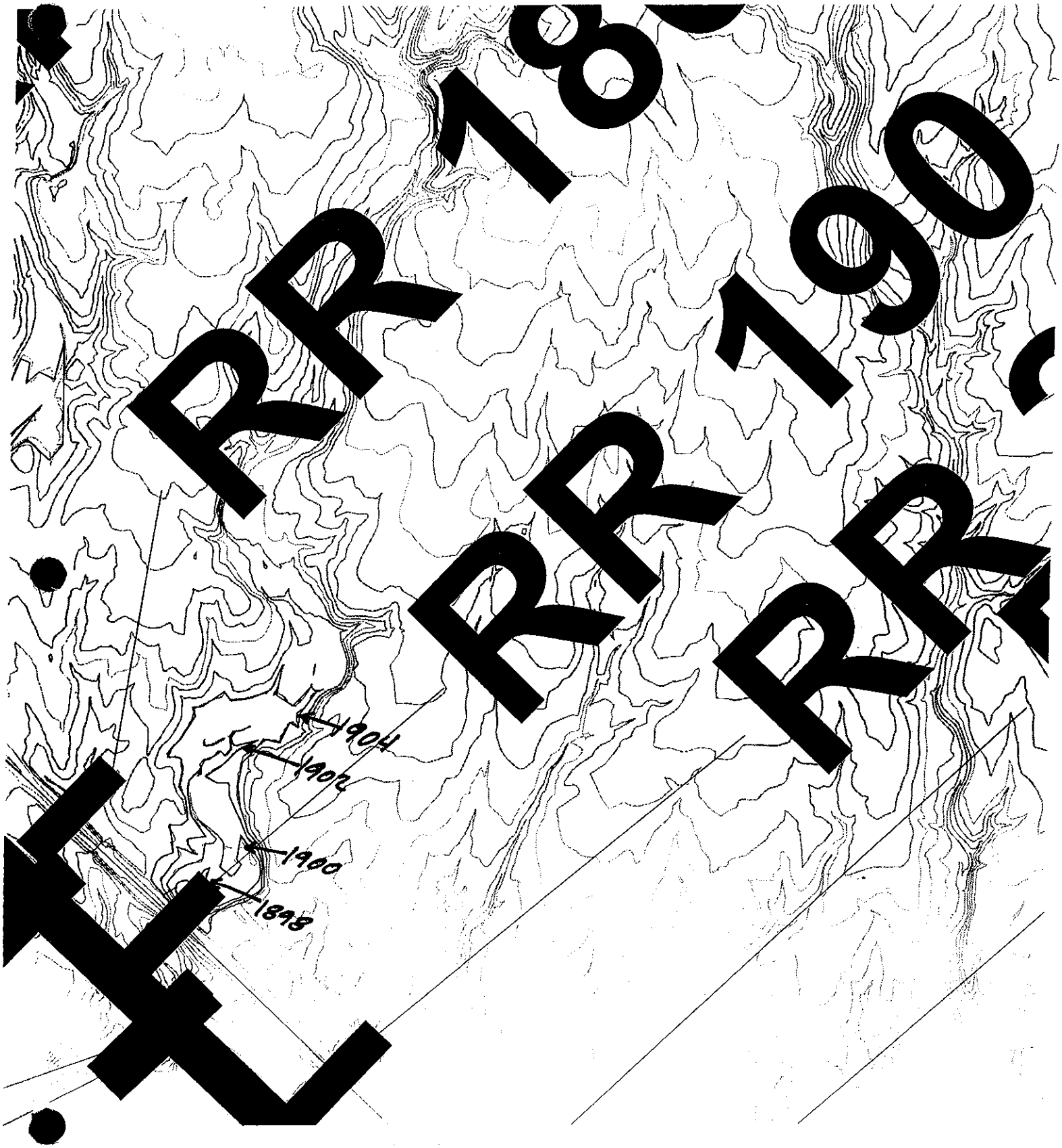


	Stage Elevation				
	1904	**1904.5**	**1905**	**1905.5**	**1906**
Rt Side Slope length (ft)	0.00	0.50	1.01	1.51	2.02
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	34.5	69.1	103.8	138.5
Perimeter, (ft)	69.0	70.0	71.0	72.0	73.0
Hyd. Radius, (ft)	0.00	0.49	0.97	1.44	1.90
Velocity, (fps)	#DIV/0!	4.08	6.41	8.33	10.01
Diversion Discharge (cfs)	**0.0**	**140.8**	**443.4**	**864.7**	**1385.9**

Sheet 6 of 7

STORAGE ESTIMATES

↑N



RR 18
RR 190
RR
RR
FL

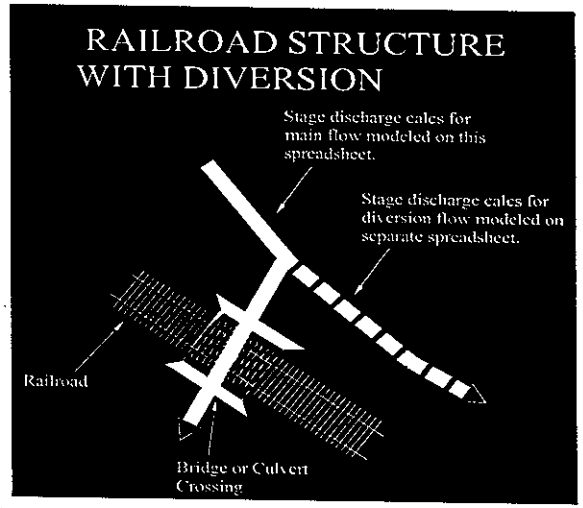
RR240

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR240 0
Station 153+50
Description 2 - 3 x 3 Box Culverts

Nomograph Input	
Culvert Invert Elevation (ft)	1884.4
Spilling Stage Elevation (ft)	1890
Width (ft)	3
Height (ft)	3
Number of Boxes	2

Sketch



	Stage Elevation								
	1884.4	**1886**	**1888**	**1890**	**1890.5**	**1891**	**1891.5**	**1892**	**1892.5**
Headwater Depth (ft)	0.00	1.60	3.60	5.60	6.10	6.60	7.10	7.60	8.10
Headwater Depth / Height	0.00	0.53	1.20	1.87	2.03	2.20	2.37	2.53	2.70
Ratio of Discharge to Width (cfs/ft)	0.00	5.00	17.00	27.00	29.00	31.00	32.00	33.00	34.00
Discharge (cfs)	0.0	30.0	102.0	162.0	174.0	186.0	192.0	198.0	204.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	16.5	51.2	98.3	155.2	220.4
Total Discharge (cfs)	0.00	30.00	102.00	162.00	190.52	237.19	290.29	353.24	424.39
Storage Area (acres)	**0**	**0.0106**	**0.0811**	**0.3731**	**0.3731**	**0.3731**	**0.3731**	**0.3731**	**0.3731**

WLB flow (cfs) 422
Calculated flow at spilling elevation (cfs) 162
Model Diversion? Yes

Sheet 1 of 4

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

CHECK MMG DATE 1/30/04

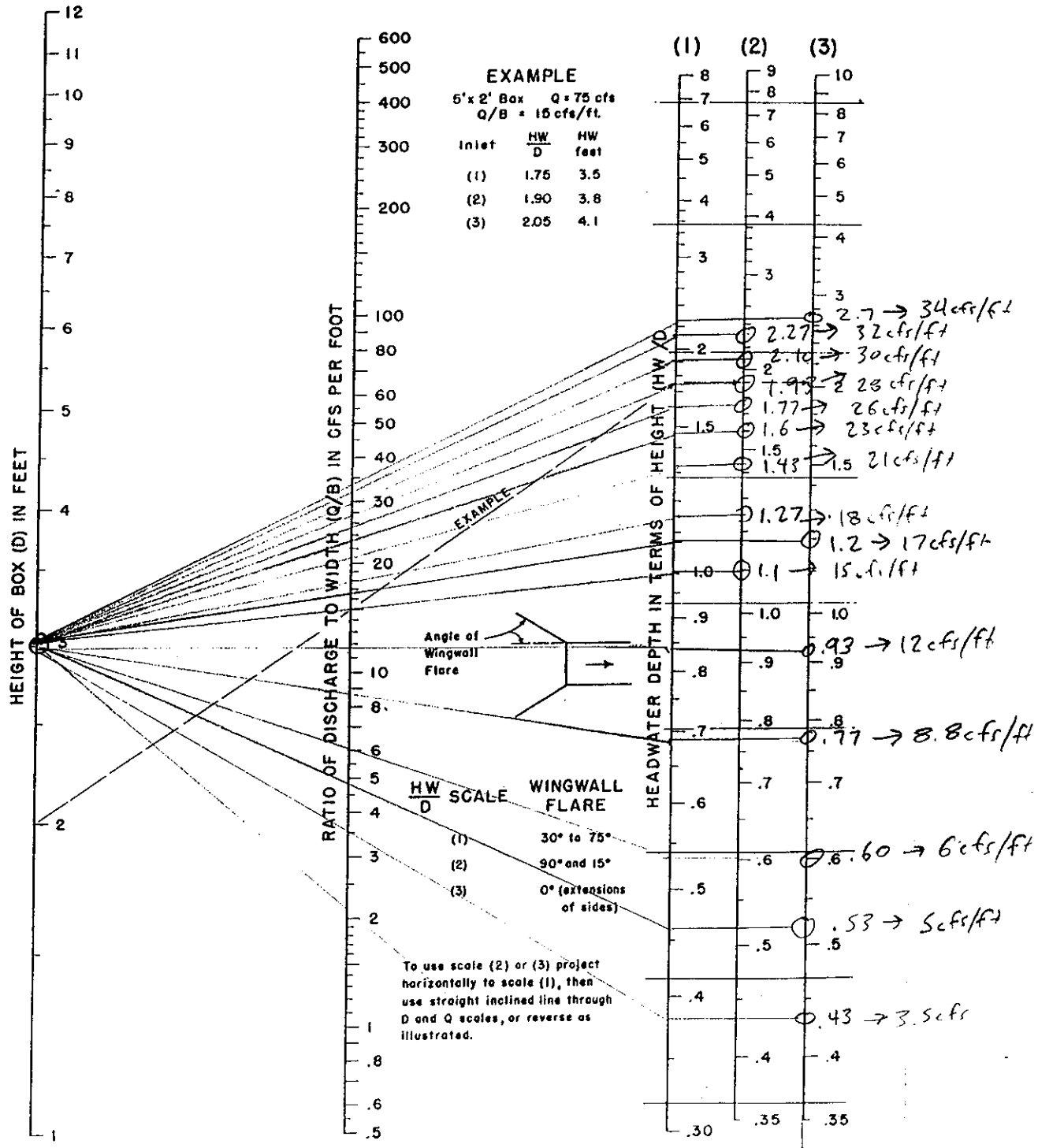
CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 310.0182

Box culvert

RR# 40, 50, 240

CHART 8



HEADWATER DEPTH FOR BOX ~~CULVERTS~~ WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Sheet 3 of 4.

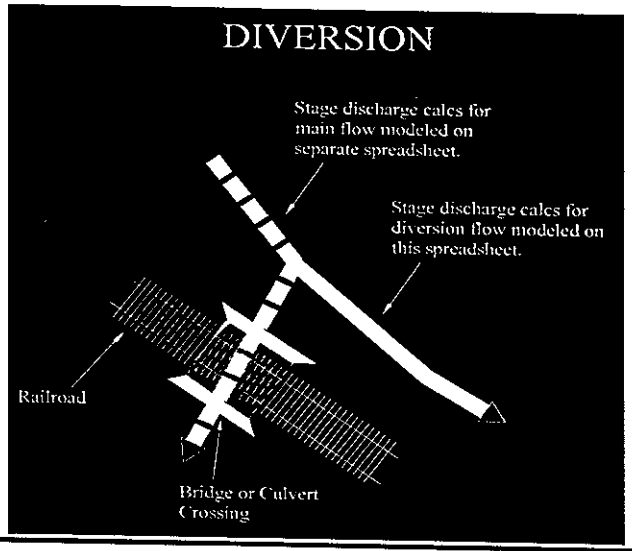
↑N

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D - 7.2

Entellus ID RR240 Diversion
Station 153+50
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1888
Upstream Channel Bottom (ft)	1890
Distance between upstream and down (ft)	662
Top Elevation (ft)	1894
Top Width (ft)	125
Side Slope, Lt, Z:1	0.078431373
Roughness "n"	0.035
Bottom Width (ft)	23
Bottom Slope, (ft/ft)	0.003021

Notes



	Stage Elevation							
	1890	1890.5	1891	1891.5	1892	1892.5	1893	1893.5
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.01	2.51	3.01	3.51
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50
X-S Area (sqft)	0.0	11.5	23.1	34.7	46.3	58.0	69.7	81.5
Perimeter, (ft)	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0
Hyd. Radius, (ft)	0.00	0.48	0.92	1.33	1.71	2.07	2.40	2.71
Velocity, (fps)	#DIV/0!	1.43	2.22	2.83	3.35	3.80	4.20	4.55
Diversion Discharge (cfs)	**0.0**	**16.5**	**51.2**	**98.3**	**155.2**	**220.4**	**292.6**	**370.8**

Sheet 4 of 4

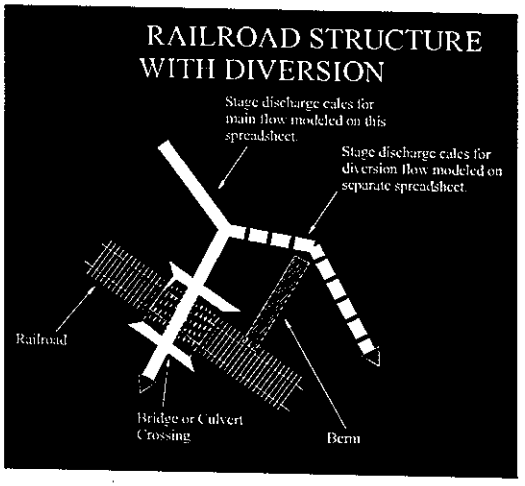
RR270

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix - D - 2

Entellus ID RR270 0
Station 153+90
Description 4' x 5' High Profile Arch

Nomograph Input	
Culvert Invert Elevation (ft)	1873.4
Spilling Stage Elevation (ft)	1880
Height (ft)	5
Width (ft)	4
Adjusted Height (ft)	3.75

Sketch



	Stage Elevation								
	1873.4	**1874**	**1876**	**1878**	**1880**	**1880.5**	**1881**	**1881.5**	**1882**
Headwater Depth (ft)	0.00	0.60	2.60	4.60	6.60	7.10	7.60	8.10	8.60
Headwater Depth / Height	0.00	0.16	0.69	1.23	1.76	1.89	2.03	2.16	2.29
Ratio of Discharge to Width (cfs/ft)	0.00	2.60	10.50	24.00	35.00	37.00	39.00	40.00	43.00
Discharge (cfs)	0.0	10.4	42.0	96.0	140.0	148.0	156.0	160.0	172.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	0.0	191.4	601.2	1169.2	1869.1
Total Discharge (cfs)	0.00	10.40	42.00	96.00	140.00	339.41	757.17	1329.23	2041.12
Storage Area (acres)	**0**	**0.0005**	**0.065**	**0.3462**	**1.0808**	**1.0808**	**1.0808**	**1.0808**	**1.0808**

WLB flow (cfs) No Similar Concentration Point
Calculated flow at spilling elevation (cfs) 140
Model Diversion? Yes

Sheet 1 of 4

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

CHECK AMG DATE 1/30/04

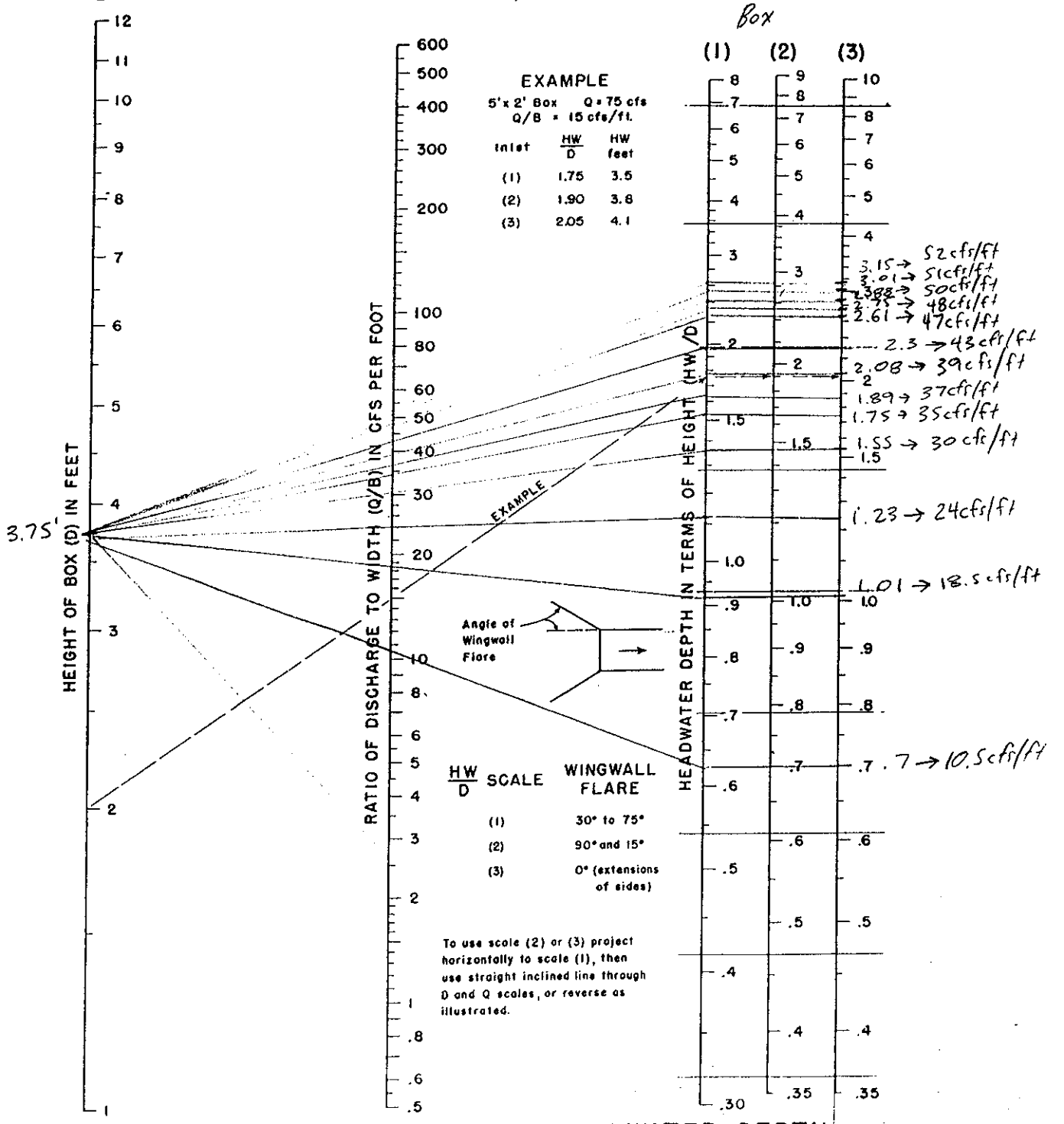
CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 3100152

HPA modeled as Box culvert

RR# 190, 270, 340, 410 : 5' High Profile Arch modeled as 3 Box

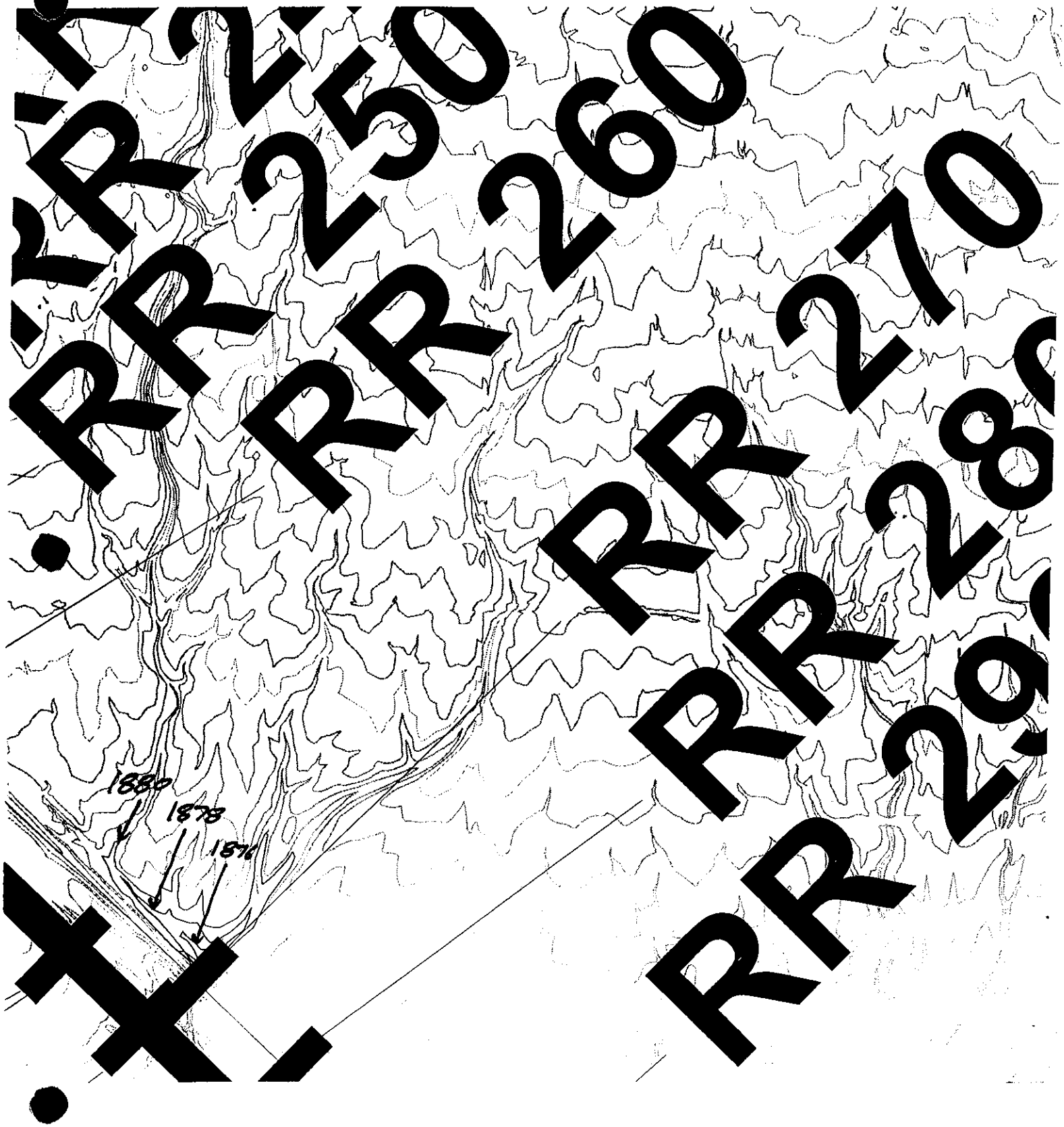
CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

↑N

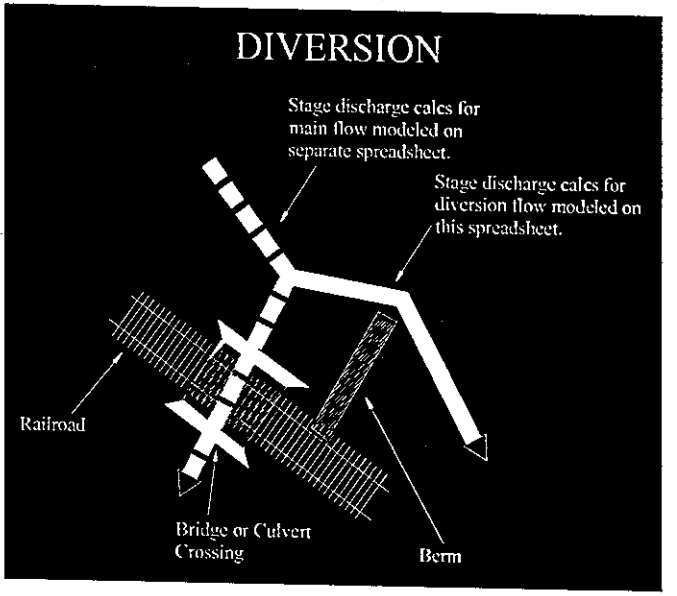


Willmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5-2

Entellus ID RR270 Diversion
Station 153+90
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1878
Upstream Channel Bottom (ft)	1880
Distance between upstream and down (ft)	28
Top Elevation (ft)	1882
Top Width (ft)	102
Side Slope, Lt, Z:1	0.083333333
Roughness "n"	0.035
Bottom Width (ft)	54
Bottom Slope, (ft/ft)	0.071429

Sketch



	Stage Elevation				
	1880	**1880.5**	**1881**	**1881.5**	**1882**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.51	2.01
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	27.0	54.1	81.2	108.3
Perimeter, (ft)	54.0	55.0	56.0	57.0	58.0
Hyd. Radius, (ft)	0.00	0.49	0.97	1.42	1.87
Velocity, (fps)	#DIV/0!	7.08	11.12	14.40	17.25
Diversion Discharge (cfs)	**0.0**	**191.4**	**601.2**	**1169.2**	**1869.1**

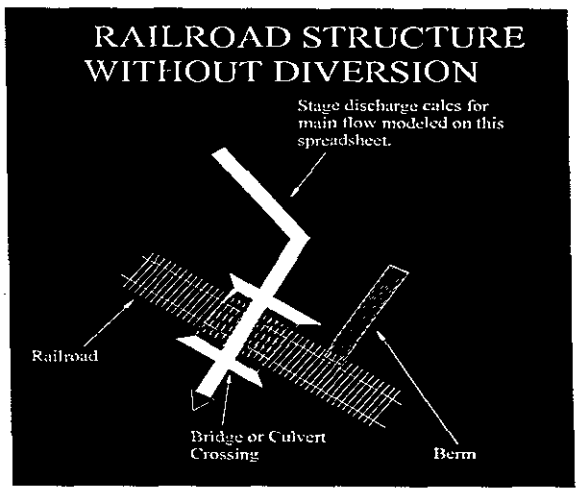
Sheet 4 of 4

RR310

Entellus ID RR310
Station 154+40
Description 17 - (8' to 1') x 16'

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1856
Downstream Channel Invert Elevation (ft)	1854
Bridge Invert Elevation (ft)	1857.6
Downstream Station (ft)	122
Spilling Stage Elevation (ft)	1860
Average Space Between Pilings (ft)	16
Number of Pilings (ft)	16
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	0
Side Slope, Lt, Z:1	0
Roughness "n"	0.035
Bottom Width (ft)	272
Clogging Factor (ft)	24
Adjusted Bottom Width (ft)	248
Bottom Slope, (ft/ft)	0.016393

Sketch



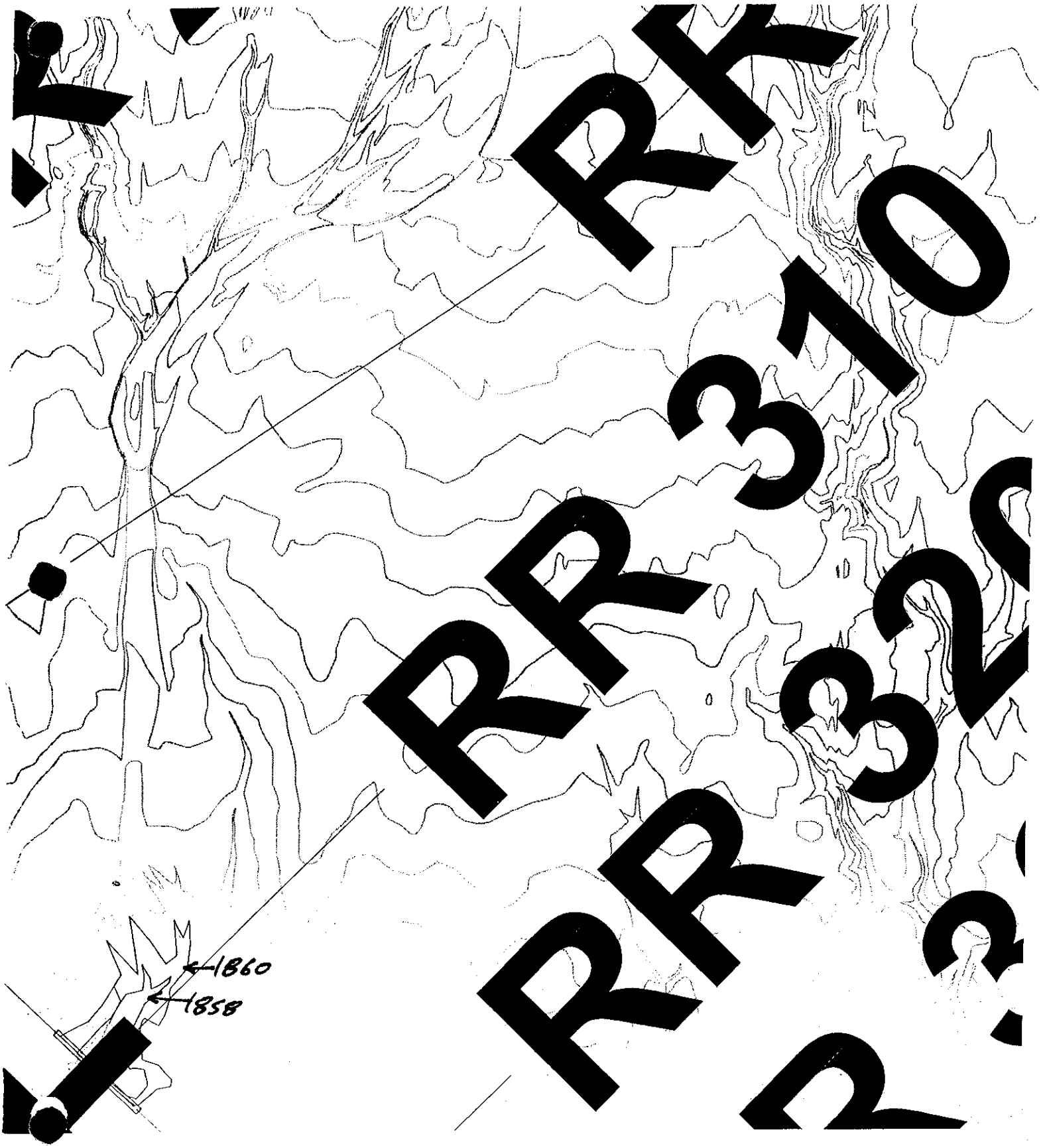
	Stage Elevation				
	1857.6	**1858**	**1860**	**1860.5**	**1861**
Rt Side Slope length (ft)	0.00	0.40	2.40	2.90	3.40
Lt Side Slope length (ft)	0.00	0.40	2.40	2.90	3.40
Flow Depth, (ft)	0.00	0.40	2.40	2.90	3.40
X-S Area (sqft)	0.0	99.2	595.2	719.2	843.2
Perimeter, (ft)	248.0	248.8	252.8	253.8	254.8
Hyd. Radius, (ft)	0.00	0.40	2.35	2.83	3.31
Velocity, (fps)	#DIV/0!	2.95	9.65	10.92	12.10
Discharge (cfs)	**0.0**	**292.9**	**5741.7**	**7850.1**	**10206.4**
Storage Area (acres)	**0**	**0.3692**	**0.9508**	**0.9508**	**0.9508**

WLB flow (cfs) 2970
Calculated flow at spilling elevation (cfs) 5741
Model Diversion? No

Sheet 1 of 2.

Sheet 2 of 2

↑N



RR 310
RR 32
RR 3

RR340, RR350 and RR360

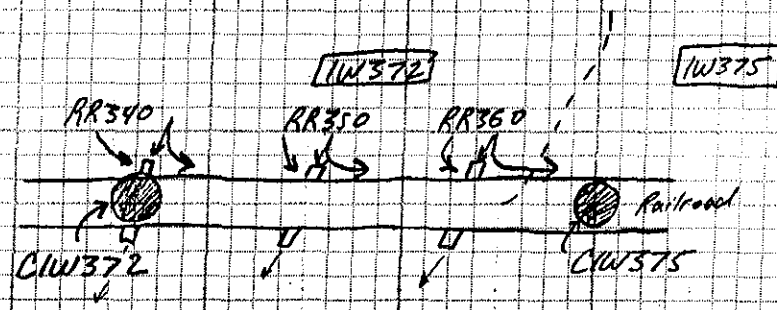
Entellus™

SHEET 1 OF 8
BY [illegible] DATE 4/5/4
CHECK CSL DATE 4/12/4

CLIENT FCD

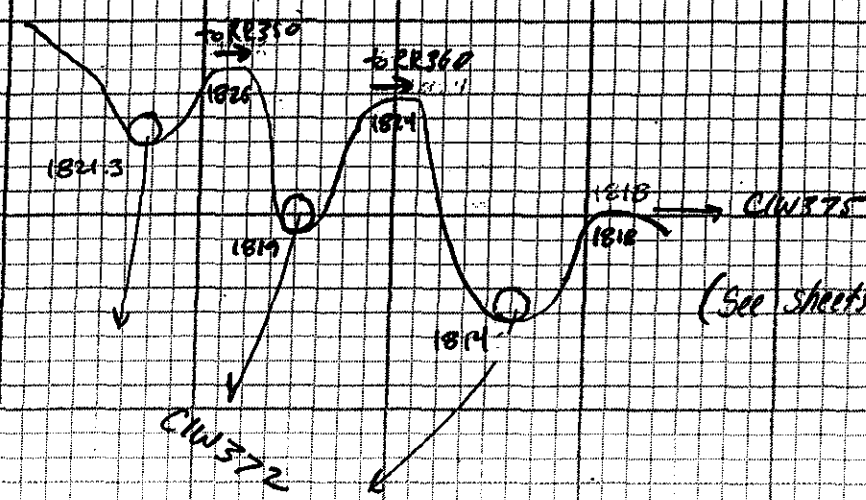
JOB NAME Wittmann ADMSU JOB NO. 310032

Stage - Discharge / Diversion: CIW372 → CIW375



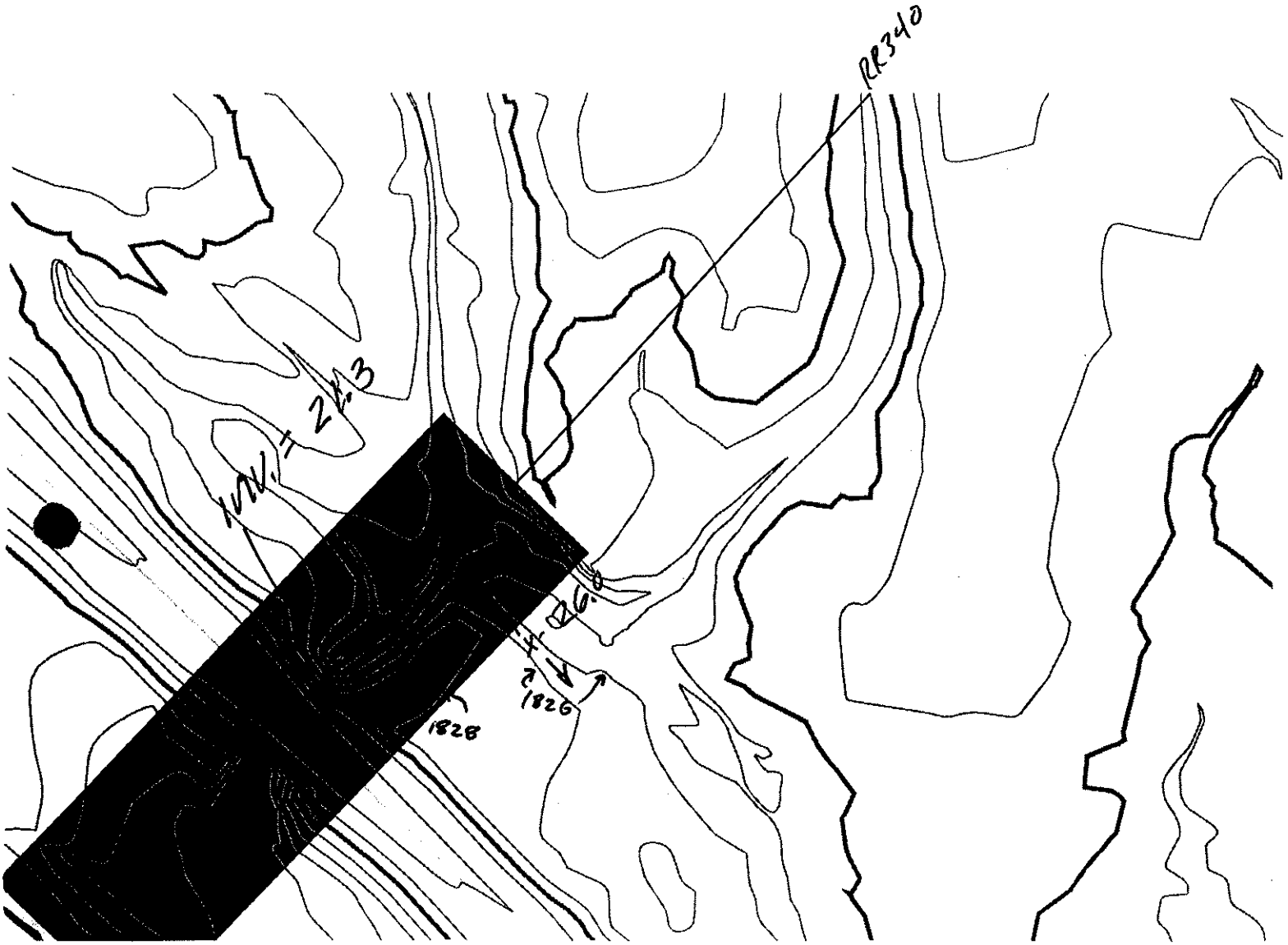
Preliminary Q = 320 cfs @ CIW372

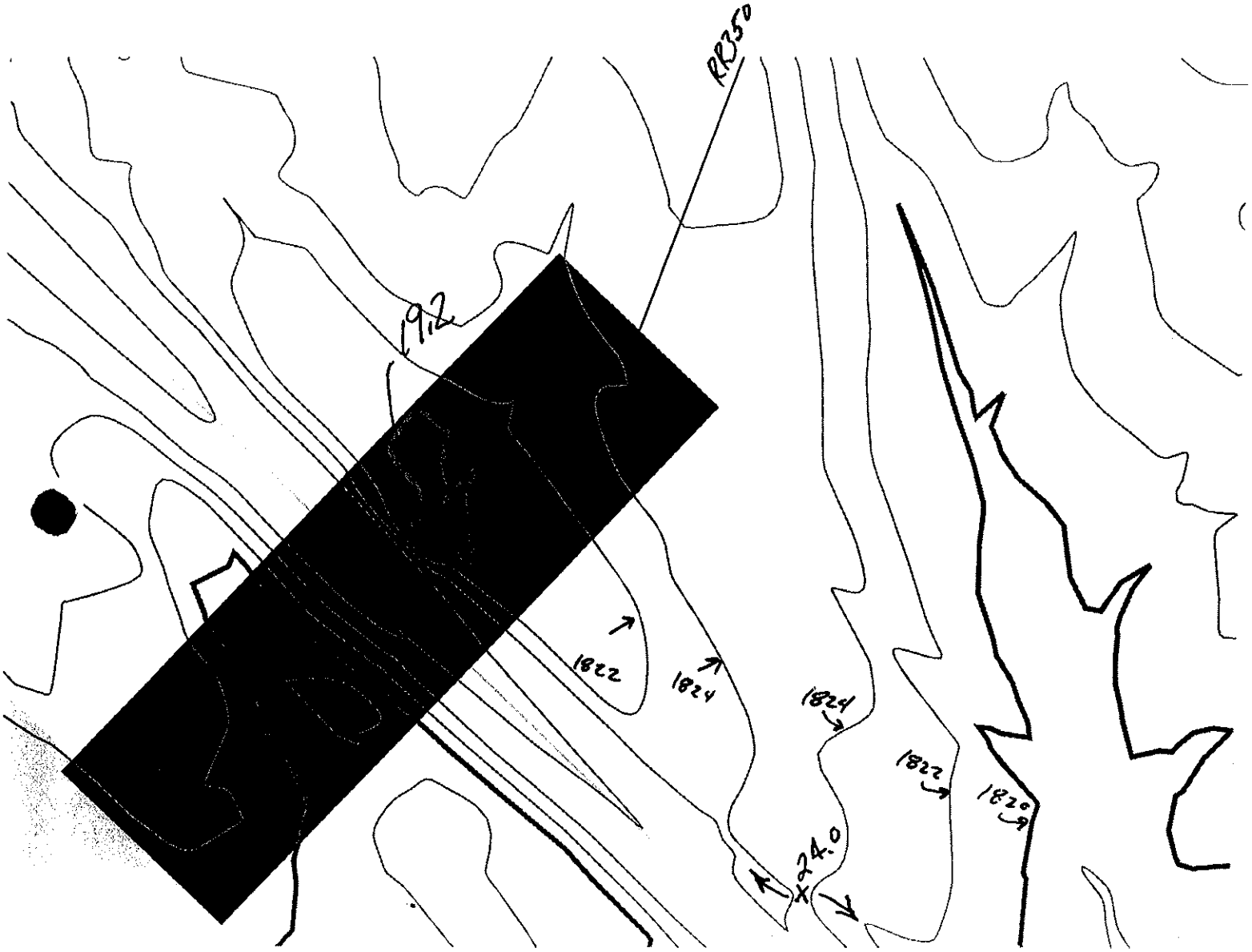
RR340: 3' x 5' HPA, Invert @ 1821.3
RR350: 36" RCP, Invert @ 1819.2
RR360: 48" RCP, Invert @ 1813.6

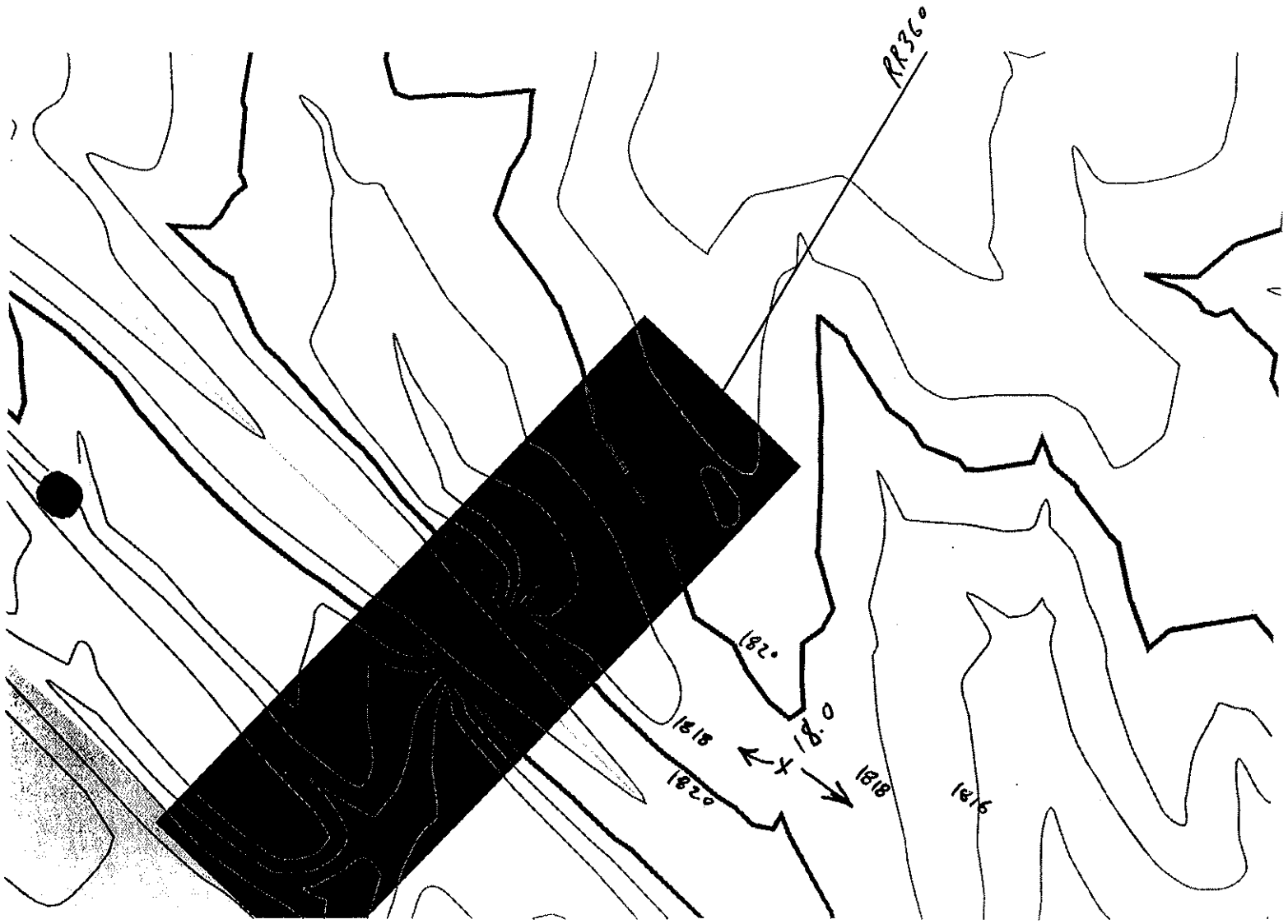


(See sheets 2, 3 and 4 for topo.)

It was been assumed that RR350 and RR360 realize there maximum discharge when the backwater begins spilling along the railroad. This is valid because the diversion flow will increase much more rapidly than the culvert discharge because the culverts are relatively small.


RR340
1828
1826


RR350
192
1822
1824
1824
1822
1820
24.0


RR360
1820
1818
1820
1818
1818
1816
X

Entellus™

SHEET 5 OF 8
BY dS DATE 4/5/4
CHECK ____ DATE ____

CLIENT FCD
JOB NAME Wittmann DOMSU JOB NO. 910082

#1 RR340		#2 RR350			#3 RR360			#4 DIVERSION	
Q	E	Q	H/D	E	Q	H/D	E	Q	E
0	1821	-	-	1819	-	-	1814	-	1818
9	1822	-	-	1819	-	-	1814	-	1818
45	1824	-	-	1819	-	-	1814	-	1818
87	1826	-	-	1819	-	-	1814	-	1818
87	1826 OT	35	1	1822	-	-	1814	-	1818
87	1826	60	1.7	1824	-	-	1814	-	1818
87	1826	60	1.7	1824 OT	24	.5	1816	-	1818
87	1826	60	1.7	1824	70	1	1818 OT	0	1818
87	1826	60	1.7	1824	110	1.5	1820	428	1820
87	1826	60	1.7	1824	140	2	1822	1375	1822
87	1826	60	1.7	1824	170	2.5	1824	2752	1824
87	1826	85	2.3	1826	200	3	1826	4548	1826

(See sheet 6 for calcs) (See sheet 8 for calcs.) (See sheet 7 for calcs)

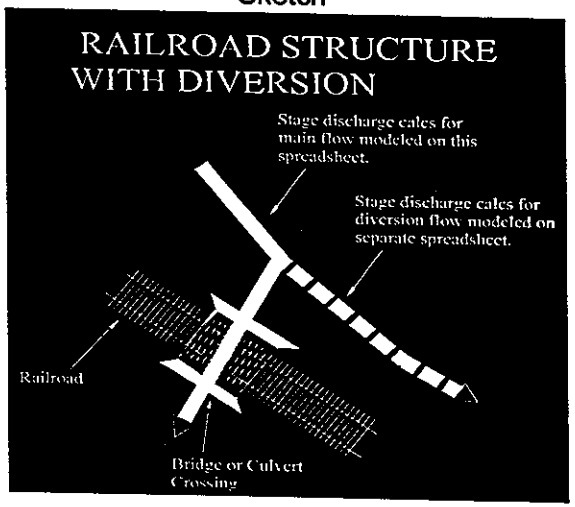
DI	0	87	122	685	1662	3069	4920
DQ	0	0	0	428	1375	2752	4548

DQ = diversion to CIW375, Column #4
DI = total flow to CIW372 before diversion, #1+#2+#3+#4

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR340
Station 154+90
Description 3' x 5' High Profile Arch

Sketch



Nomograph Input	
Culvert Invert Elevation (ft)	1821.3
Spilling Stage Elevation (ft)	1818
Height (ft)	5
Width (ft)	3
Adjusted Height (ft)	3.75

	Stage Elevation							
	1821.3	1822	1824	1826	1826.5	1827	1827.5	1828
Headwater Depth (ft)	0.00	0.70	2.70	4.70	5.20	5.70	6.20	6.70
Headwater Depth / Height	0.00	0.19	0.72	1.25	1.39	1.52	1.65	1.79
Ratio of Discharge to Width (cfs/ft)	0.00	3.00	15.00	29.00	36.00	38.00	42.00	46.00
Discharge (cfs)	0.0	9.0	45.0	87.0	108.0	114.0	126.0	138.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	41.7	130.5	252.8	402.7
Total Discharge (cfs)	0.00	9.00	45.00	87.00	149.70	244.50	378.80	540.70
Storage Area (acres)	0	0.0966	0.4323	0.9616	1.917	1.917	1.917	1.917

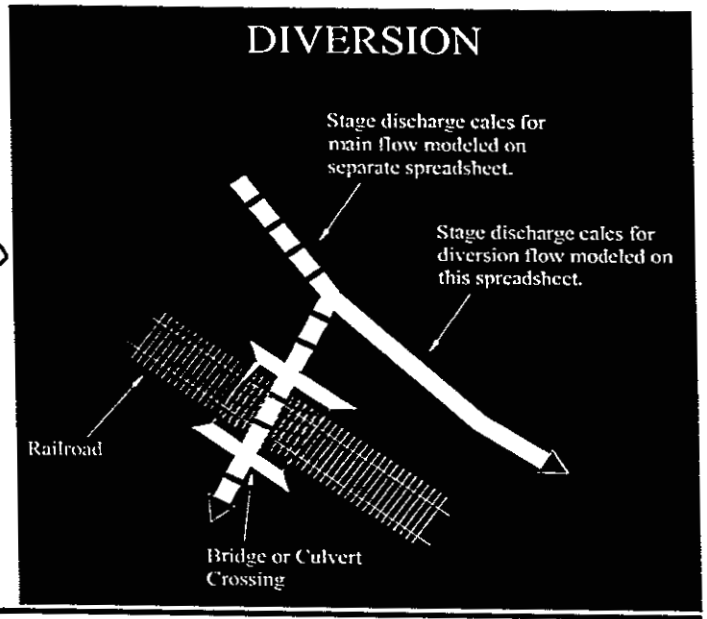
WLB flow (cfs) 188
Calculated flow at spilling elevation (cfs) 108
Model Diversion? Yes

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID ~~RR240~~ Diversion
Station 154+90 RR360
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1816
Upstream Channel Bottom (ft)	1818
Distance between upstream and down (ft)	180
Top Elevation (ft)	1828
Top Width (ft)	47 1.2
Side Slope, Lt, Z:1	1.176470588
Roughness "n"	0.035
Bottom Width (ft)	30
Bottom Slope, (ft/ft)	0.011111

Sketch



	Stage Elevation				
	1818	**1820**	**1822**	**1824**	**1826**
Rt Side Slope length (ft)	0.00	3.09	6.18	9.26	12.35
Flow Depth, (ft)	0.00	2.00	4.00	6.00	8.00
X-S Area (sqft)	0.0	64.7	138.8	222.4	315.3
Perimeter, (ft)	30.0	36.2	42.4	48.5	54.7
Hyd. Radius, (ft)	0.00	1.79	3.28	4.58	5.76
Velocity, (fps)	#DIV/0!	6.61	9.90	12.38	14.43
Diversion Discharge (cfs)	**0.0**	**427.8**	**1374.6**	**2752.6**	**4548.2**

Entellus™

CIW372

SHEET 8 OF 8

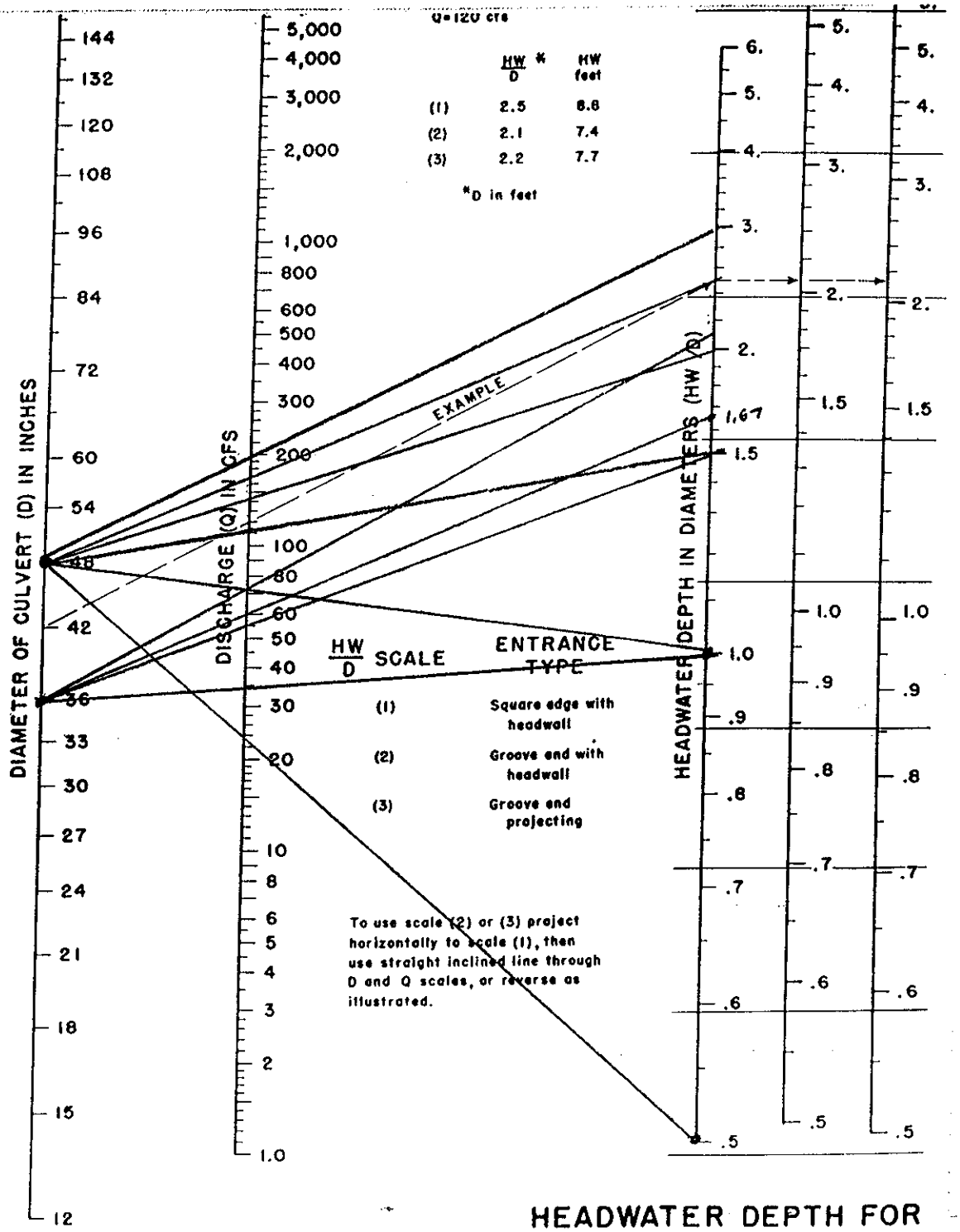
BY dS DATE 4/5/14

CHECK ____ DATE ____

CLIENT FCD

JOB NAME Wittmann ADMSU

JOB NO. 310032



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

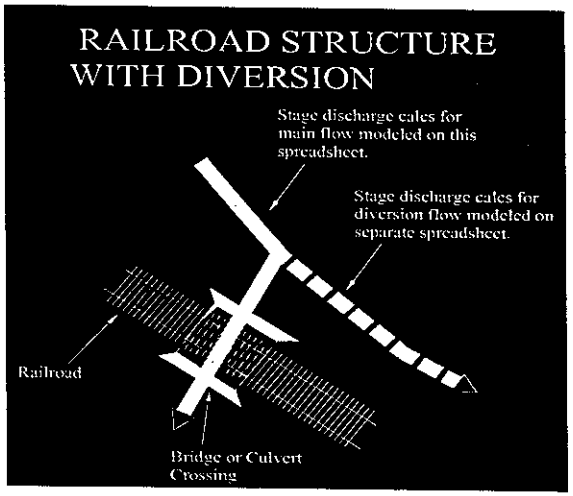
RR370

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix C - 7 - 2

Entellus ID	RR370	0
Station	155+30	
Description	2 - 3 x 4 Box Culverts	

Nomograph Input	
Culvert Invert Elevation (ft)	1803.9
Spilling Stage Elevation (ft)	1810
Width (ft)	3
Height (ft)	4
Number of Boxes	2

Sketch



	Stage Elevation								
	1803.9	**1806**	**1808**	**1810**	**1810.5**	**1811**	**1811.5**	**1812**	**1812.5**
Headwater Depth (ft)	0.00	2.10	4.10	6.10	6.60	7.10	7.60	8.10	8.60
Headwater Depth / Height	0.00	0.52	1.02	1.52	1.65	1.77	1.90	2.02	2.15
Ratio of Discharge to Width (cfs/ft)	0.00	7.50	21.00	34.00	37.00	38.00	40.00	42.00	45.00
Discharge (cfs)	0.0	45.0	126.0	204.0	222.0	228.0	240.0	252.0	270.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	49.4	153.6	296.0	469.2	668.2
Total Discharge (cfs)	0.00	45.00	126.00	204.00	271.36	381.58	536.01	721.15	938.20
Storage Area (acres)	**0**	**0.0298**	**0.6754**	**1.6969**	**1.6969**	**1.6969**	**1.6969**	**1.6969**	**1.6969**

WLB flow (cfs) 288
Calculated flow at spilling elevation (cfs) 204
Model Diversion? Yes

Note: This diversion was not included in the HEC-1 model.
See memo 13-31-4 for details.

Sheet 1 of 4

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

CHECK AWG DATE 1/30/04

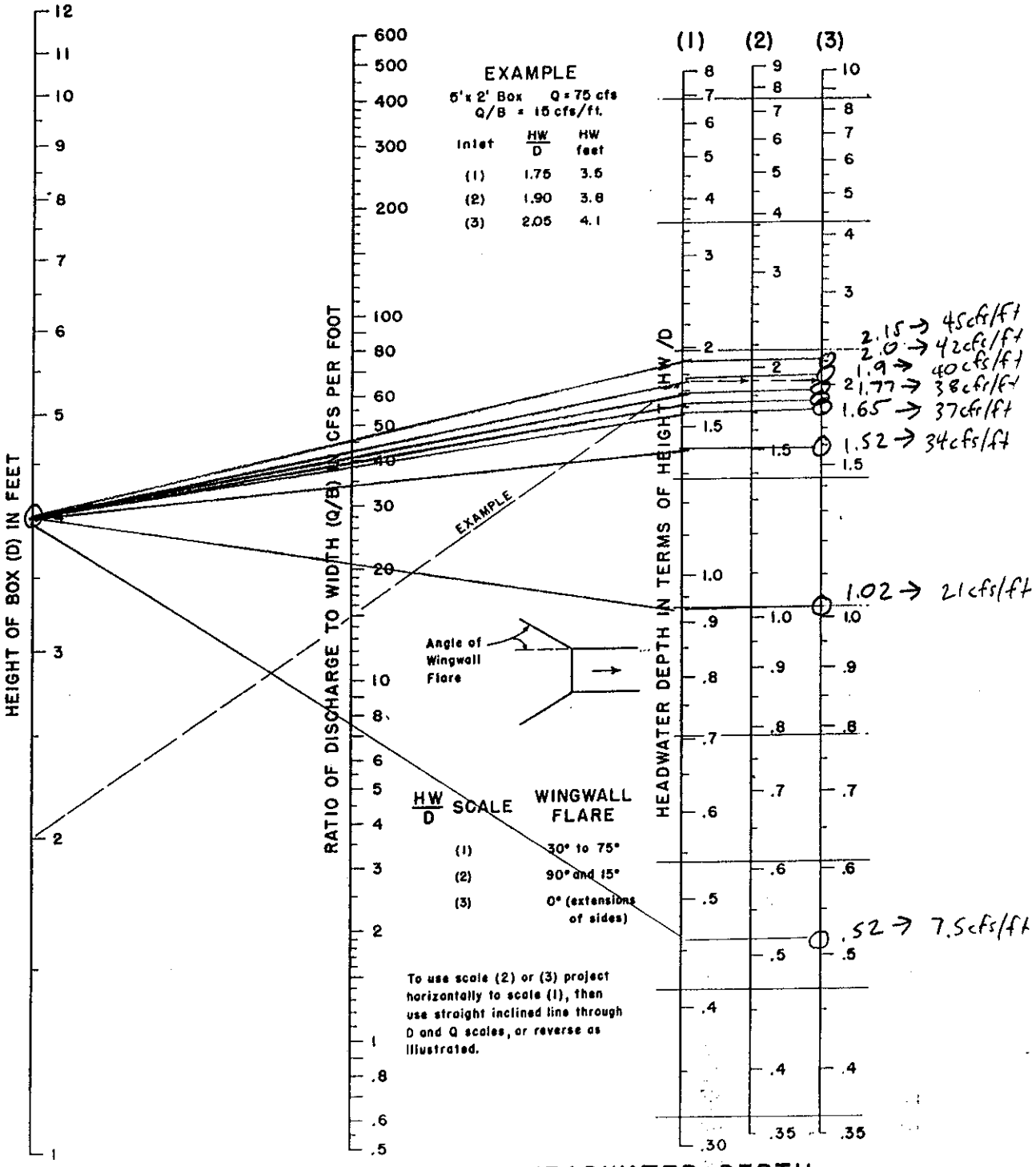
CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 310.0132

~~[illegible]~~ ~~[illegible]~~ Box culvert

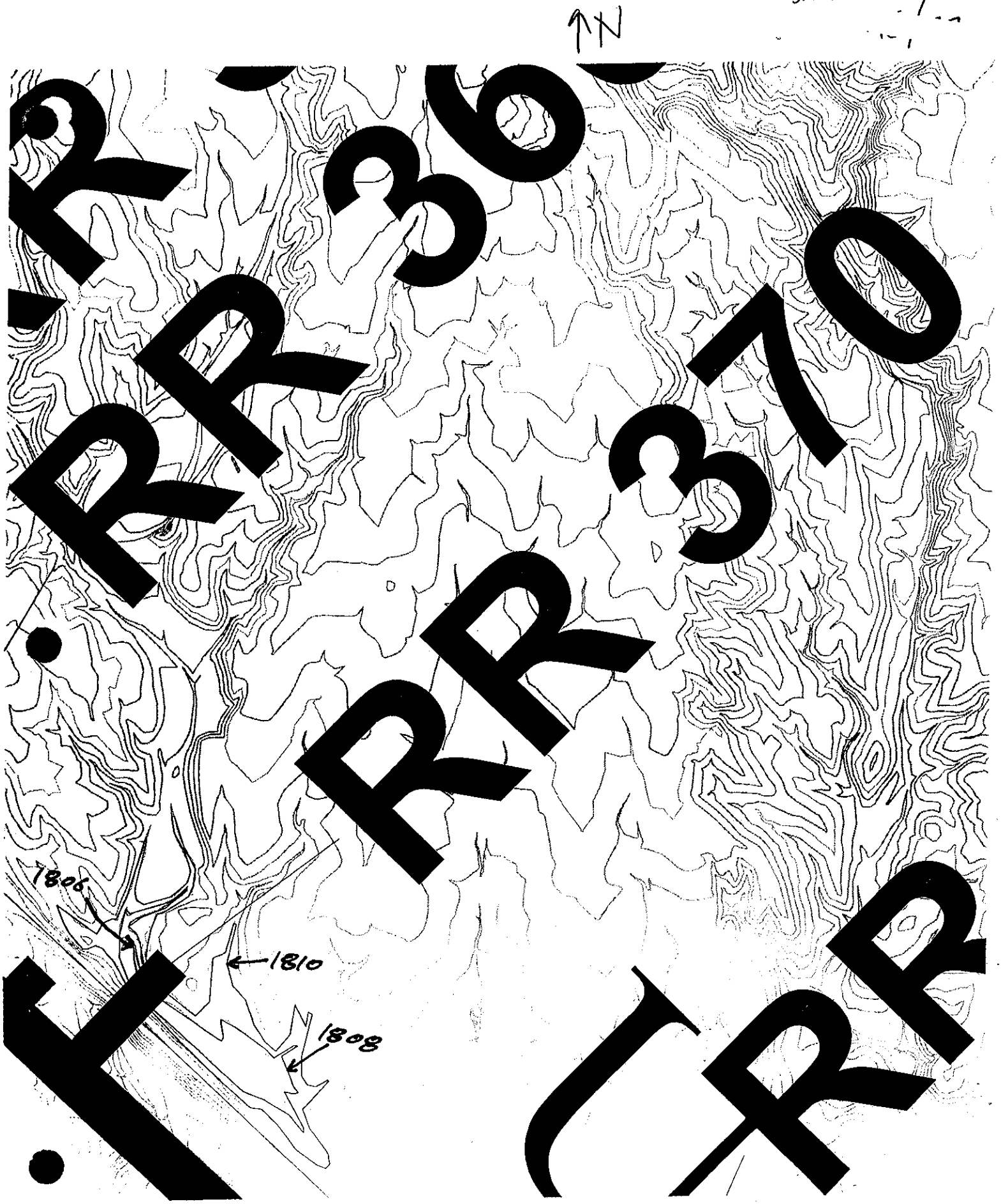
RR# 370

CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963



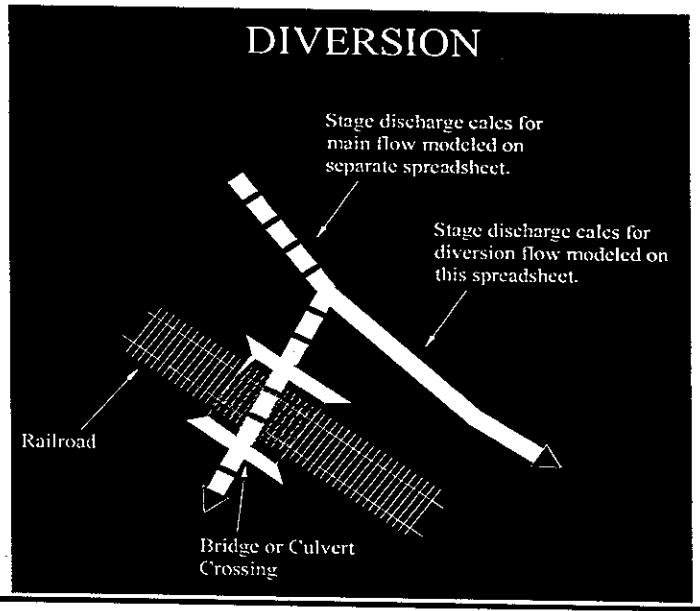
RR 367
RR 370
RR

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-2

Entellus ID RR370 Diversion
Station 155+30
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1808
Upstream Channel Bottom (ft)	1810
Distance between upstream and down (ft)	119
Top Elevation (ft)	1812
Top Width (ft)	100
Side Slope, Lt, Z:1	0.056338028
Roughness "n"	0.035
Bottom Width (ft)	29
Bottom Slope, (ft/ft)	0.016807

Sketch



	Stage Elevation					
	1810	**1810.5**	**1811**	**1811.5**	**1812**	**1812.5**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00	2.50
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00	2.50
X-S Area (sqft)	0.0	14.5	29.1	43.6	58.2	72.9
Perimeter, (ft)	29.0	30.0	31.0	32.0	33.0	34.0
Hyd. Radius, (ft)	0.00	0.48	0.94	1.36	1.76	2.14
Velocity, (fps)	#DIV/0!	3.40	5.29	6.79	8.06	9.17
Diversion Discharge (cfs)	**0.0**	**49.4**	**153.6**	**296.0**	**469.2**	**668.2**

Sheet 4 of 4

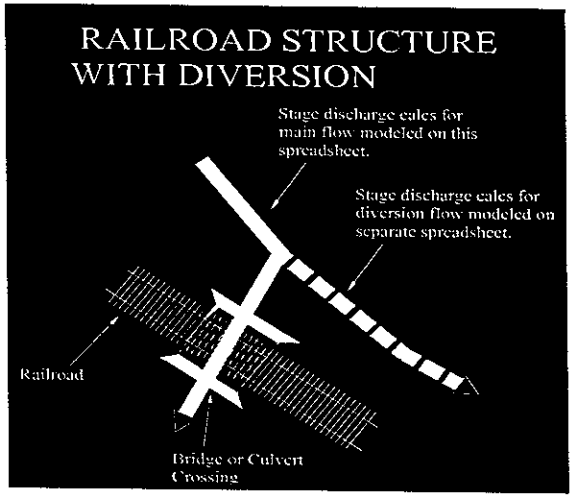
RR410

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR410
Station 155+80
Description 3' x 5' High Profile Arch

Nomograph Input	
Culvert Invert Elevation (ft)	1777.5
Spilling Stage Elevation (ft)	1786
Height (ft)	5
Width (ft)	3
Adjusted Height (ft)	3.75

Sketch



	Stage Elevation								
	1777.5	1778	1780	1782	1784	1786	1786.5	1787	1787.5
Headwater Depth (ft)	0.00	0.50	2.50	4.50	6.50	8.50	9.00	9.50	10.00
Headwater Depth / Height	0.00	0.13	0.67	1.20	1.73	2.27	2.40	2.53	2.67
Ratio of Discharge to Width (cfs/ft)	0.00	10.50	24.00	35.00	43.00	48.00	51.00	52.00	53.00
Discharge (cfs)	0.0	31.5	72.0	105.0	129.0	144.0	153.0	156.0	159.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.8	221.5
Total Discharge (cfs)	0.00	31.50	72.00	105.00	129.00	144.00	153.00	226.78	380.54
Storage Area (acres)	0	0.0033	0.104	0.5677	1.3701	2.4378	2.4378	2.4378	2.4378

WLB flow (cfs) 236
Calculated flow at spilling elevation (cfs) 144
Model Diversion? Yes

Sheet 1 of 9

Entellus™

SHEET 2 OF 4

BY _____ DATE _____

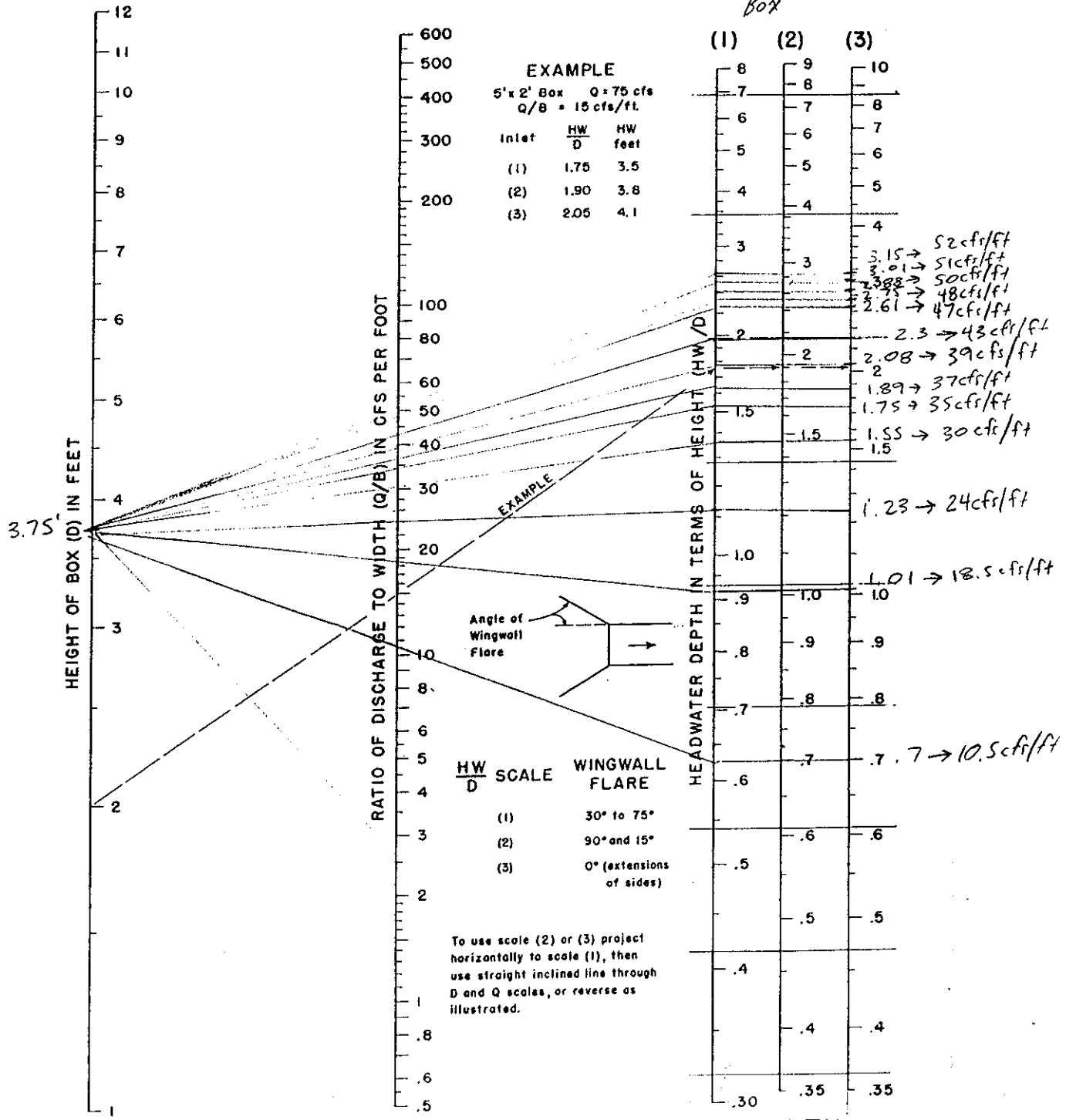
CHECK AWG DATE 1/30/04

CLIENT FCDMC

JOB NAME Wittmann Area Drainage Master Study JOB NO. 3100182

HPA modeled as Box culvert
RR# 190, 270, 340, 410 : 5' High Profile Arch modeled as 3 Box

CHART 8

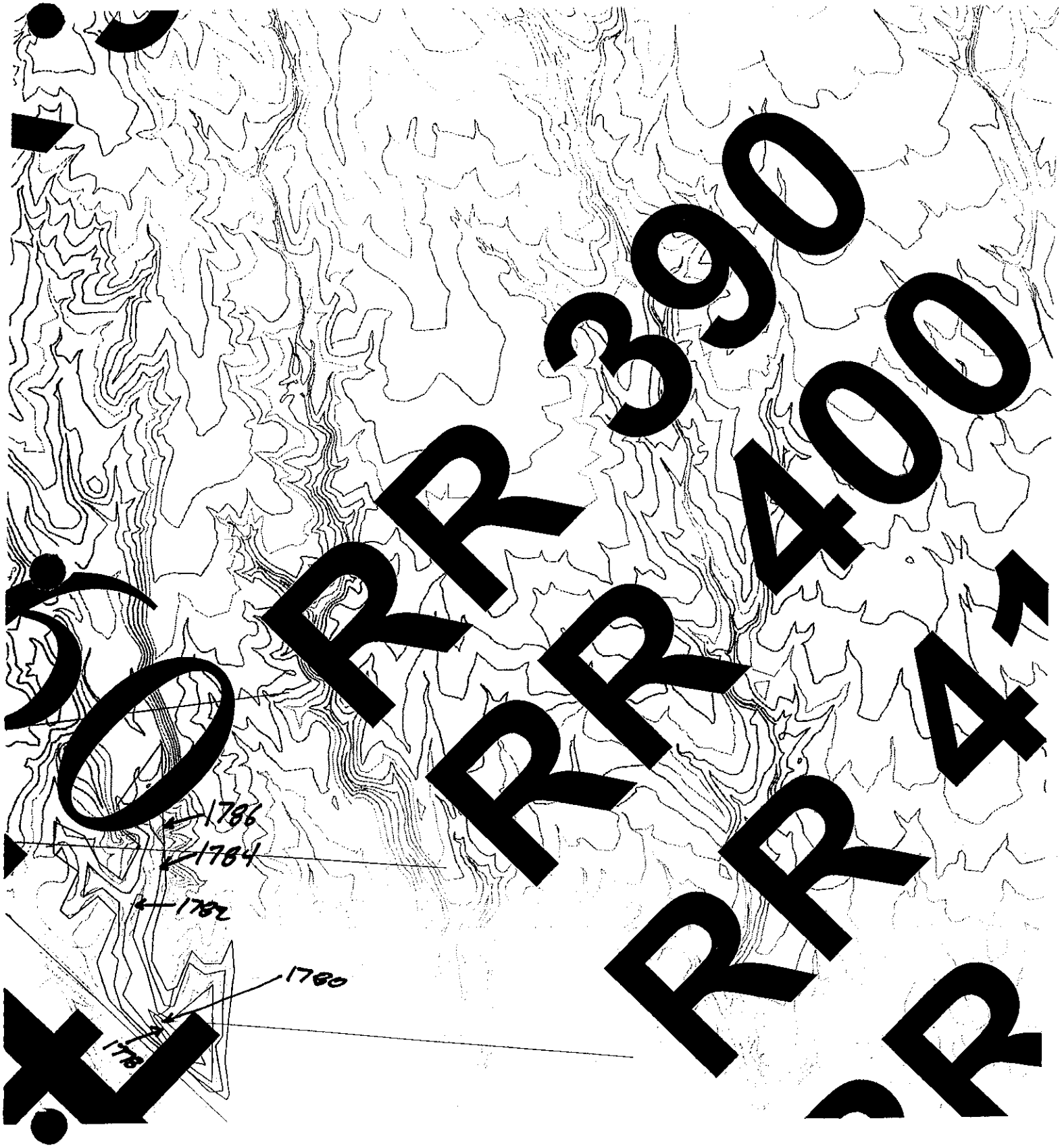


HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Sheet 3 of 4

TN



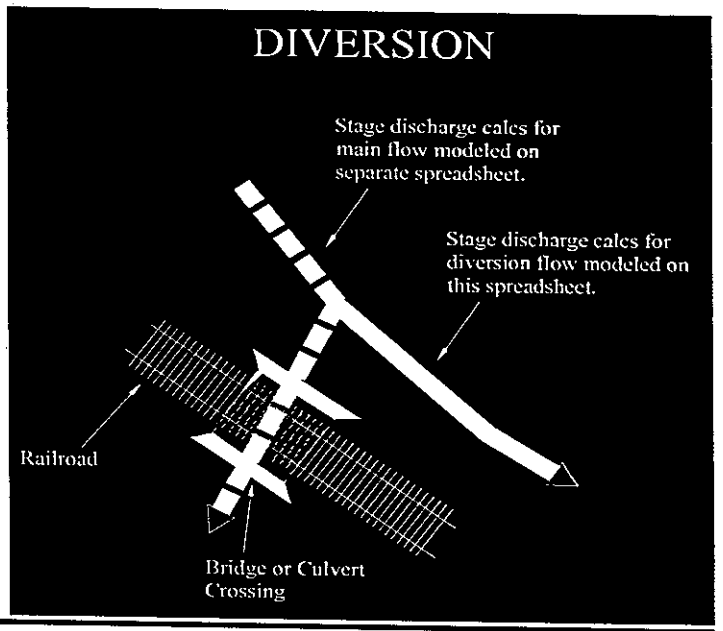
RR 390
RR 400
RR 4
RR

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-2

Entellus ID RR410 Diversion
Station 155+80
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1784
Upstream Channel Bottom (ft)	1786
Distance between upstream and down (ft)	123
Top Elevation (ft)	1788
Top Width (ft)	110
Side Slope, Lt, Z:1	0.058823529
Roughness "n"	0.035
Bottom Width (ft)	42
Bottom Slope, (ft/ft)	0.016260

Sketch



	Stage Elevation				
	1786	**1786.5**	**1787**	**1787.5**	**1788**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	21.0	42.1	63.1	84.2
Perimeter, (ft)	42.0	43.0	44.0	45.0	46.0
Hyd. Radius, (ft)	0.00	0.49	0.96	1.40	1.83
Velocity, (fps)	#DIV/0!	3.37	5.27	6.80	8.12
Diversion Discharge (cfs)	**0.0**	**70.8**	**221.5**	**429.5**	**684.4**

Sheet 4 of 4

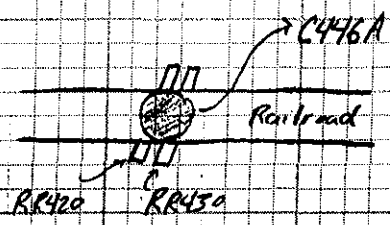
RR420 and RR430

Entellus™

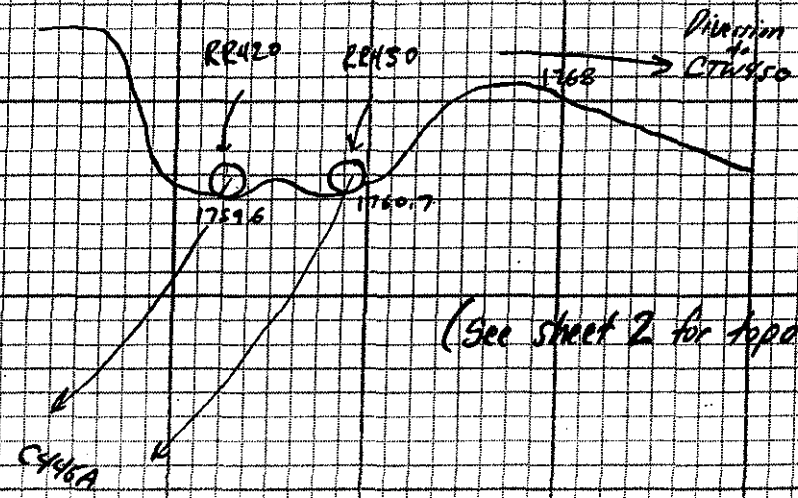
SHEET 1 OF 6
BY [illegible] DATE 4/5/14
CHECK CJ DATE 4/13/14

CLIENT FCD
JOB NAME Wittmann ADMSC JOB NO. 310032

STAGE - DISCHARGE/DIVERSION: C446A



RR420: 1-3'x5' HPA, Invert @ 1759.6 ft
RR450: 2-66" CMP, Invert @ 1760.7 → both inverts modeled @ 1760 ft



(See sheet 2 for topo)

See the attached spreadsheets for data

DI	0	98	395	2499	6509
DO	0	0	0	1845	5770

flow diverted from C446A to CTW450 estimated on sheet 4
Total inflow estimated on sheets 3 and 4.

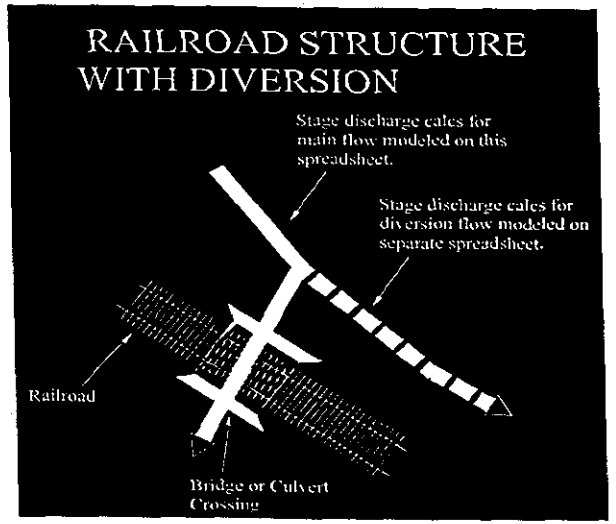
RR420
RR 430
59.6
1762
1764
1766
1768
60.7
78

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Enteilus ID RR420,RR430
Station 156+1, 156+11
Description 3' x 5' High Profile Arch and 2 - 66" CMP

Nomograph Input	
Culverts Invert Elevation (ft)	1760
Spilling Stage Elevation (ft)	1768
RR420 Height (ft)	5
RR420 Width (ft)	3
RR420 Adjusted Height (ft)	3.75
RR430 Diameter (ft)	5.5

Sketch



	Stage Elevation								
	1760	1762	1764	1766	1768	1770	1772	1774	1776
Headwater Depth (ft)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
RR420 Headwater Depth / Height	0.00	0.53	1.07	1.60	2.13	2.67	3.20	3.73	4.27
RR 420 Ratio of Discharge to Width (cfs/ft)	0.00	8.00	23.00	35.00	45.00	54.00	60.00	65.00	70.00
RR420 Discharge (cfs)	0.0	24.0	69.0	105.0	135.0	162.0	180.0	195.0	210.0
RR430 Headwater Depth / Diameter	0.0	0.4	0.7	1.1	1.5	1.8	2.2	2.5	2.9
RR430 Discharge (cfs)	0.0	90.0	190.0	360.0	540.0	600.0	680.0	750.0	820.0
Diversion Discharge (cfs)	0.0	0.0	0.0	0.0	0.0	1845.0	5769.9	11179.1	17810.9
Total Discharge (cfs)	0.00	98.00	213.00	395.00	585.00	2499.00	6509.88	11994.13	18700.88

Estimated from sheet 6

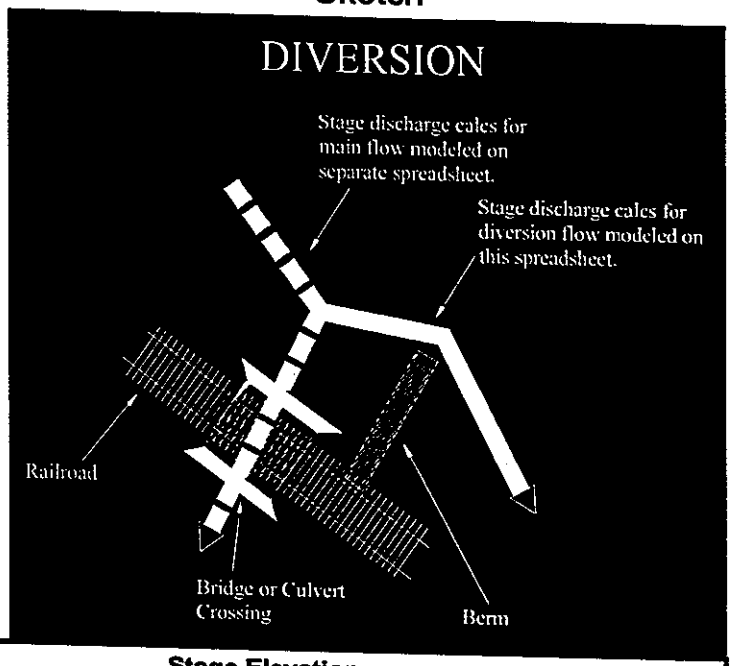
Estimated from sheet 7

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR420 and RR430
Station 156+1, 156+11
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1764
Upstream Channel Bottom (ft)	1768
Distance between upstream and down (ft)	275
Top Elevation (ft)	1770
Top Width (ft)	130 0.27
Side Slope, Lt, Z:1	0.266666667
Roughness "n"	0.035
Bottom Width (ft)	115
Bottom Slope, (ft/ft)	0.014545 0.015

Sketch



	Stage Elevation				
	1768	1770	1772	1774	1776
Rt Side Slope length (ft)	0.00	2.07	4.14	6.21	8.28
Flow Depth, (ft)	0.00	2.00	4.00	6.00	8.00
X-S Area (sqft)	0.0	231.1	464.3	699.6	937.1
Perimeter, (ft)	115.0	119.1	123.3	127.4	131.6
Hyd. Radius, (ft)	0.00	1.94	3.77	5.49	7.12
Velocity, (fps)	#DIV/0!	7.98	12.43	15.98	19.01
Diversion Discharge (cfs)	**0.0**	**1845.0**	**5769.9**	**11179.1**	**17810.9**

Sheet 4 of 6

C446A

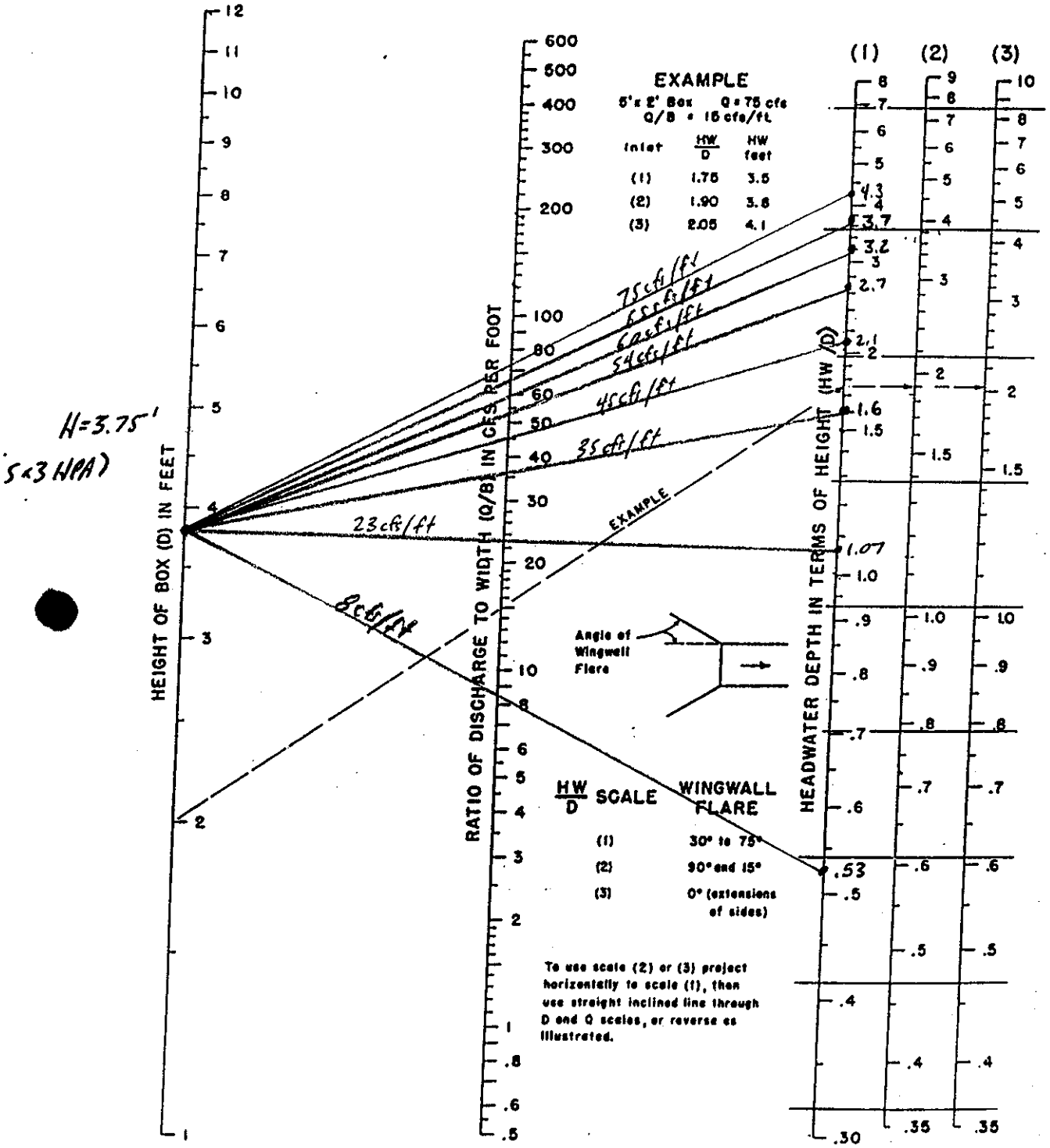


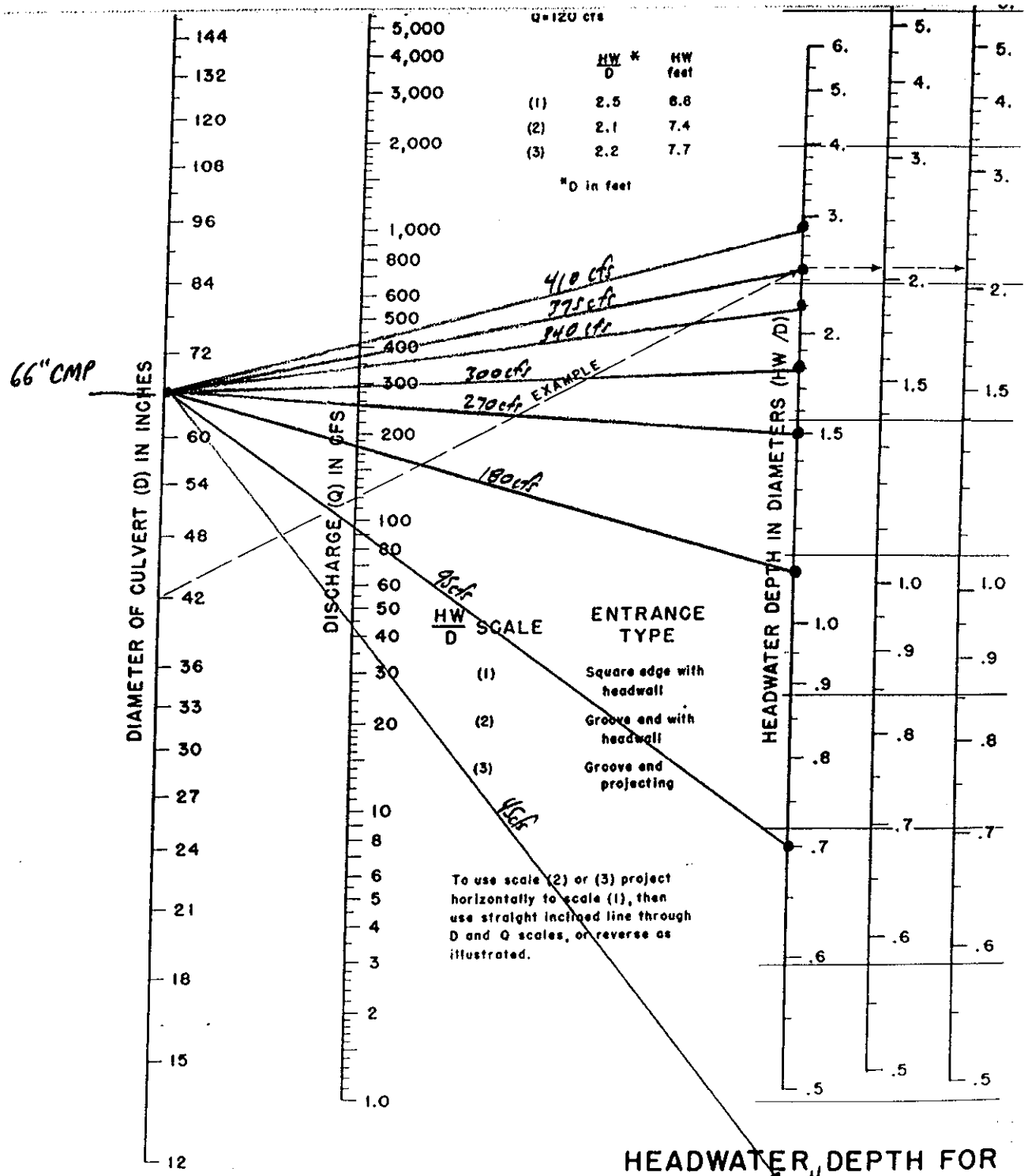
Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT, FHWA, HDS-5, 1985)

Entellus™

C446A

SHEET 6 OF 6
BY JS DATE 4/5/14
CHECK ____ DATE ____

CLIENT FCD
JOB NAME Wittmann DOMSG
JOB NO. 310032



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

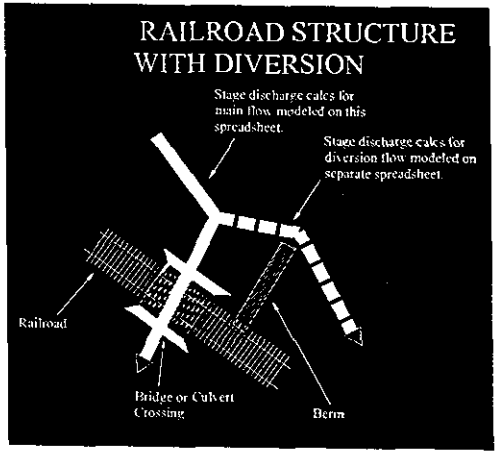
RR450

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D, Sheet 2

Entellus ID RR450
Station 156+70
Description 6 - 13' x 9' Wooden Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1740
Downstream Channel Invert Elevation (ft)	1738
Bridge Invert Elevation (ft)	1741.1
Downstream Station (ft)	55
Spilling Stage Elevation (ft)	1744
Average Space Between Pilings (ft)	13
Number of Pilings (ft)	5
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	1
Side Slope, Lt, Z:1	1
Roughness "n"	0.035
Bottom Width (ft)	52
Clogging Factor (ft)	7.5
Adjusted Bottom Width (ft)	44.5
Bottom Slope, (ft/ft)	0.036364

Sketch



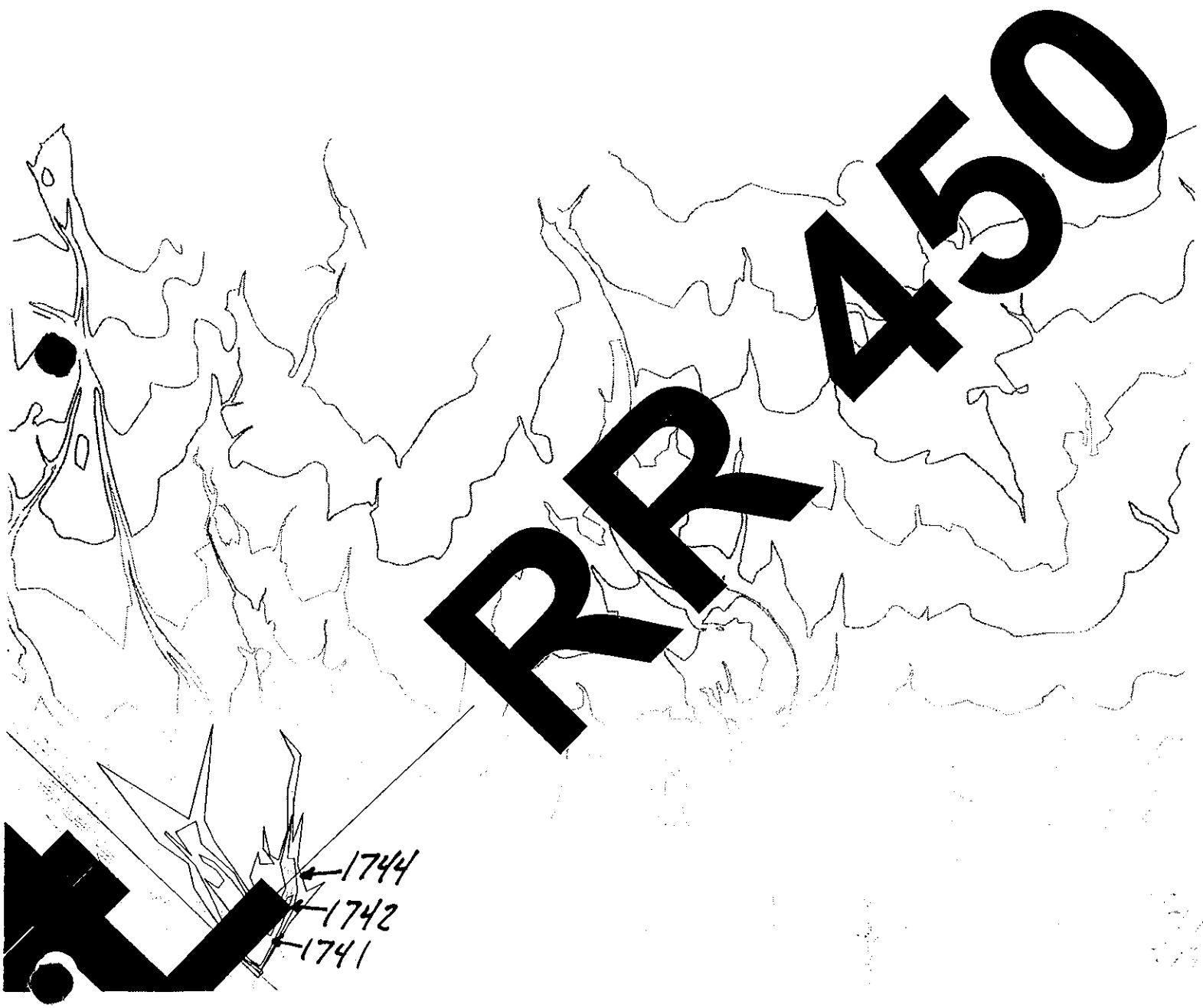
	Stage Elevation				
	1741.1	**1742**	**1744**	**1744.5**	**1745**
Rt Side Slope length (ft)	0.00	1.27	4.10	4.81	5.52
Lt Side Slope length (ft)	0.00	1.27	4.10	4.81	5.52
Flow Depth, (ft)	0.00	0.90	2.90	3.40	3.90
X-S Area (sqft)	0.0	40.9	137.5	162.9	188.8
Perimeter, (ft)	44.5	47.0	52.7	54.1	55.5
Hyd. Radius, (ft)	0.00	0.87	2.61	3.01	3.40
Velocity, (fps)	#DIV/0!	7.39	15.38	16.92	18.35
Discharge (cfs)	**0.0**	**302.0**	**2114.4**	**2755.8**	**3464.3**
Diversion Discharge (cfs)	**0.0**	**0.0**	**0.0**	**180.6**	**351.0**
Total Discharge (cfs)	**0.0**	**302.0**	**2114.4**	**2936.5**	**3815.3**
Storage Area (acres)	**0.1943**	**0.4387**	**1.0250**	**1.025**	**1.025**

WLB flow (cfs) No Similar Concentration Point
Calculated flow at spilling elevation (cfs) 2114
Model Diversion? Yes

Sht 1 of 3

Sheet 2 of 3

↑N



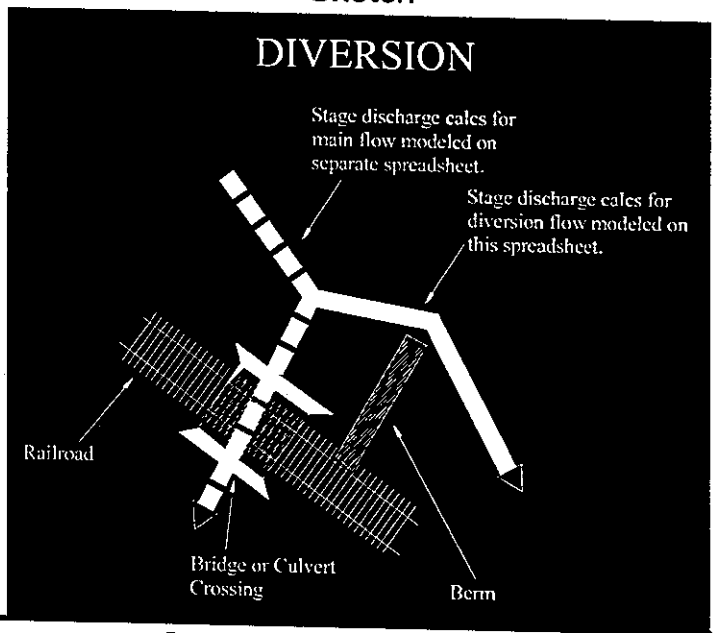
RR 450

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D.5.2

Entellus ID RR450 Diversion
Station 156+70
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1742
Upstream Channel Bottom (ft)	1744
Distance between upstream and down (ft)	265
Top Elevation (ft)	1746
Top Width (ft)	100
Side Slope, Lt, Z:1	0.08
Roughness "n"	0.035
Bottom Width (ft)	50
Bottom Slope, (ft/ft)	0.007547

Sketch



	Stage Elevation				
	1744	**1744.5**	**1745**	**1745.5**	**1746**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.01
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	25.0	50.1	75.2	100.3
Perimeter, (ft)	50.0	51.0	52.0	53.0	54.0
Hyd. Radius, (ft)	0.00	0.49	0.96	1.42	1.86
Velocity, (fps)	#DIV/0!	2.30	3.61	4.67	5.59
Diversion Discharge (cfs)	**0.0**	**57.6**	**180.6**	**351.0**	**560.6**

Sheet 3 of 3.

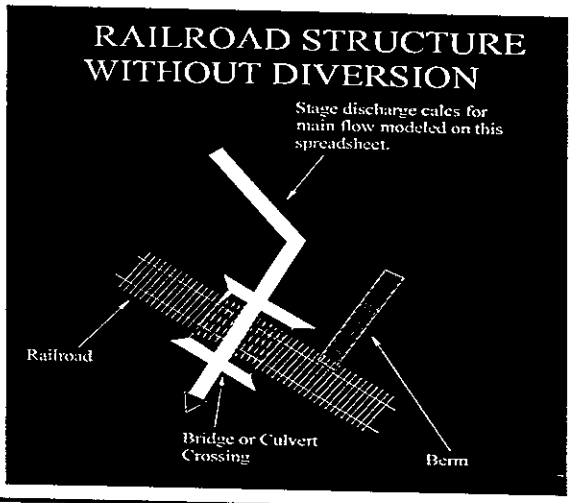
RR460

Willmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5-2

Entellus ID RR460
Station 157+00
Description 5 - 13' x 7' Wooden Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1722
Downstream Channel Invert Elevation (ft)	1720
Bridge Invert Elevation (ft)	1722.3
Downstream Station (ft)	124
Spilling Stage Elevation (ft)	1726
Average Space Between Pilings (ft)	13
Number of Pilings (ft)	4
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	0
Side Slope, Lt, Z:1	0
Roughness "n"	0.035
Bottom Width (ft)	65
Clogging Factor (ft)	6
Adjusted Bottom Width (ft)	59
Bottom Slope, (ft/ft)	0.016129

Sketch



	Stage Elevation				
	1722.3	**1724**	**1726**	**1726.5**	**1727**
Rt Side Slope length (ft)	0.00	1.70	3.70	4.20	4.70
Lt Side Slope length (ft)	0.00	1.70	3.70	4.20	4.70
Flow Depth, (ft)	0.00	1.70	3.70	4.20	4.70
X-S Area (sqft)	0.0	100.3	218.3	247.8	277.3
Perimeter, (ft)	59.0	62.4	66.4	67.4	68.4
Hyd. Radius, (ft)	0.00	1.61	3.29	3.68	4.05
Velocity, (fps)	#DIV/0!	7.42	11.95	12.88	13.75
Discharge (cfs)	**0.0**	**744.1**	**2609.6**	**3191.4**	**3811.8**
Storage Area (acres)	**0**	**0.3179**	**0.7742**	**0.7742**	**0.7742**

WLB flow (cfs) 810
Calculated flow at spilling elevation (cfs) 2609
Model Diversion? No

Sheet 1 of 2

RR460
RR47
RR
RR

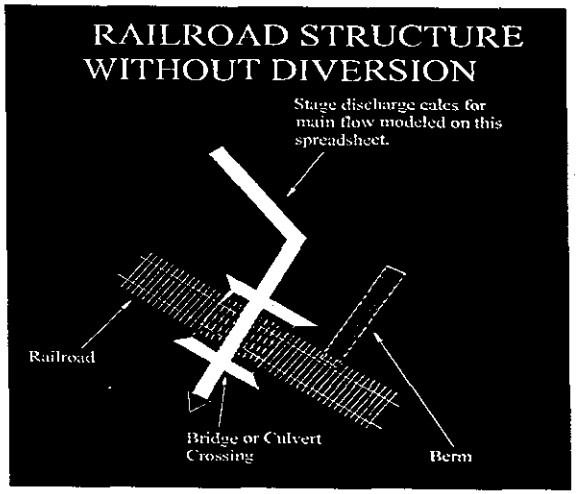
RR510

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix - D - 2

Entellus ID RR510
Station 158+10
Description 5 - 28' x 8' Concrete Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1676
Downstream Channel Invert Elevation (ft)	1674
Bridge Invert Elevation (ft)	1678.2
Downstream Station (ft)	111
Spilling Stage Elevation (ft)	1680
Average Space Between Pilings (ft)	28
Number of Pilings (ft)	4
Width of Pilings (ft)	1.15
Side Slope, Rt, Z:1	1.3
Side Slope, Lt, Z:1	3.4
Roughness "n"	0.035
Bottom Width (ft)	100
Clogging Factor (ft)	6.9
Adjusted Bottom Width (ft)	93.1
Bottom Slope, (ft/ft)	0.018018

Sketch

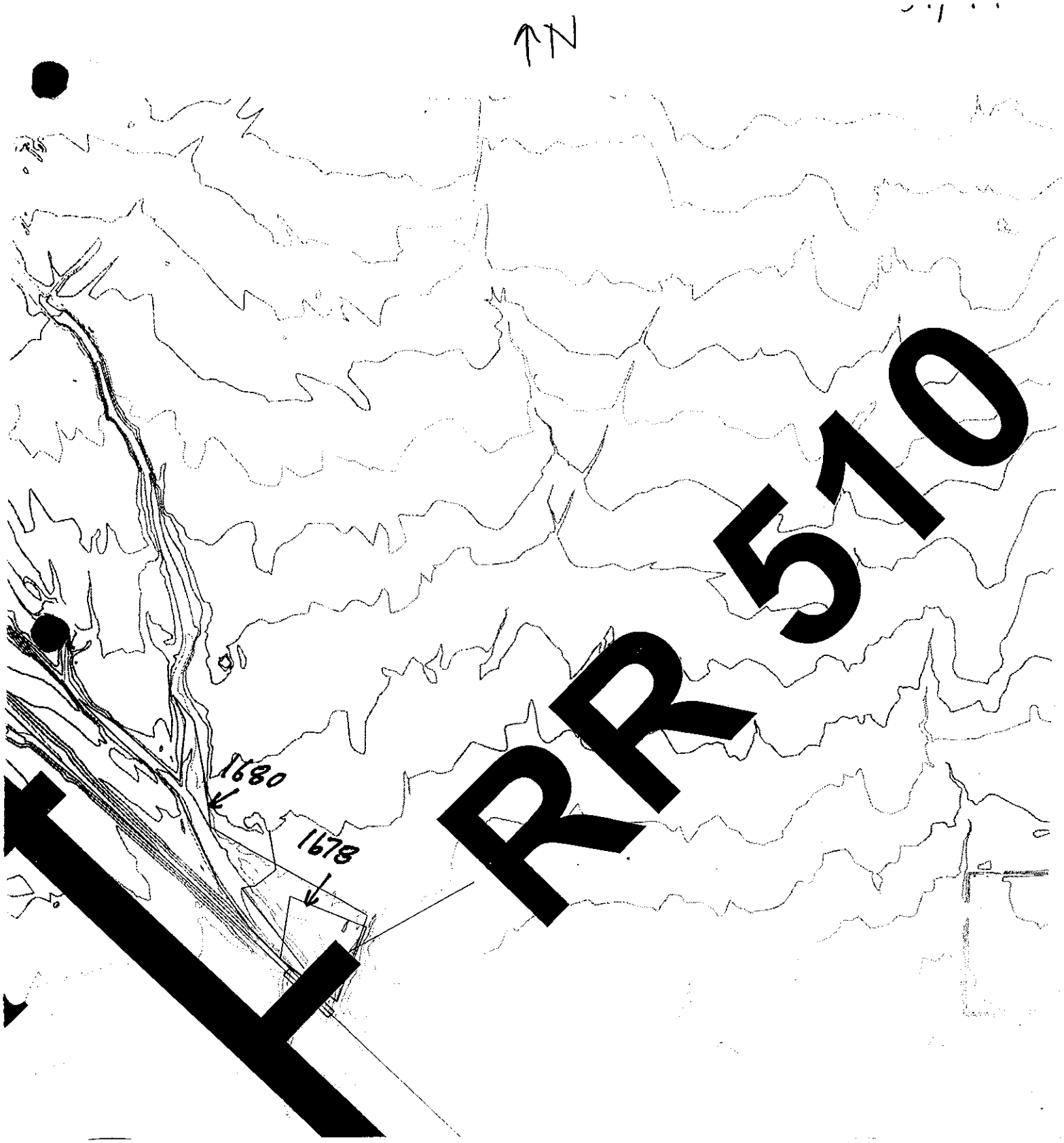


	Stage Elevation				
	1678.2	**1680**	**1680.5**	**1681**	**1681.5**
Rt Side Slope length (ft)	3.61	6.56	7.38	8.20	9.02
Lt Side Slope length (ft)	7.80	14.18	15.95	17.72	19.49
Flow Depth, (ft)	2.20	4.00	4.50	5.00	5.50
X-S Area (sqft)	221.3	426.8	487.8	550.5	614.9
Perimeter, (ft)	104.5	113.8	116.4	119.0	121.6
Hyd. Radius, (ft)	2.12	3.75	4.19	4.63	5.06
Velocity, (fps)	9.42	13.79	14.85	15.86	16.83
Discharge (cfs)	**2085.0**	**5886.1**	**7244.4**	**8732.8**	**10351.3**
Storage Area (acres)	**0.603**	**1.8293**	**1.8293**	**1.8293**	**1.8293**

WLB flow (cfs) 270
Calculated flow at spilling elevation (cfs) 5886
Model Diversion? No

Sheet 1 of 2

Sheet 2 of 2



RR 510

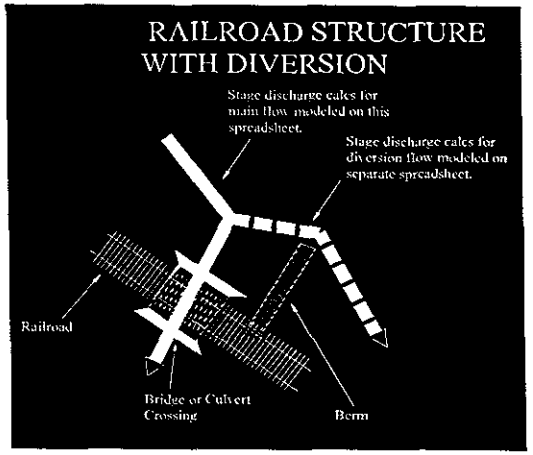
RR520

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5-2

Entellus ID RR520
Station 158+80
Description 4 - 13' x 8' Wooden Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1648
Downstream Channel Invert Elevation (ft)	1646
Bridge Invert Elevation (ft)	1645.81
Downstream Station (ft)	259
Spilling Stage Elevation (ft)	1652
Average Space Between Pilings (ft)	13
Number of Pilings (ft)	3
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	1
Side Slope, Lt, Z:1	1
Roughness "n"	0.035
Bottom Width (ft)	31.5
Clogging Factor (ft)	4.5
Adjusted Bottom Width (ft)	27
Bottom Slope, (ft/ft)	0.007722

Sketch



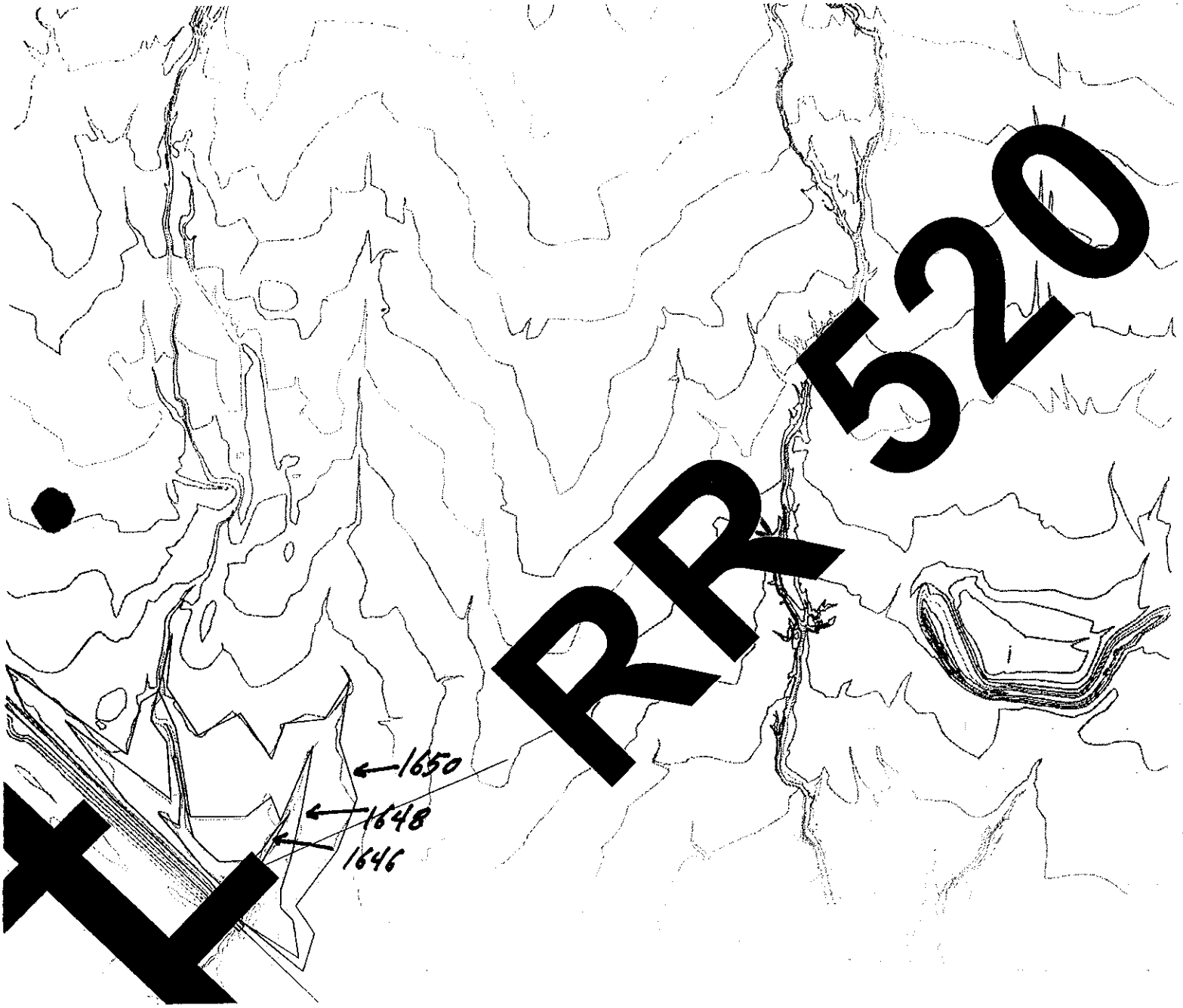
	Stage Elevation					
	1645.81	**1646**	**1648**	**1650**	**1652**	**1653**
Rt Side Slope length (ft)	0.00	0.27	3.10	5.93	8.75	10.17
Lt Side Slope length (ft)	0.00	0.27	3.10	5.93	8.75	10.17
Flow Depth, (ft)	0.00	0.19	2.19	4.19	6.19	7.19
X-S Area (sqft)	0.0	5.2	63.9	130.7	205.4	245.8
Perimeter, (ft)	27.0	27.5	33.2	38.9	44.5	47.3
Hyd. Radius, (ft)	0.00	0.19	1.93	3.36	4.62	5.19
Velocity, (fps)	#DIV/0!	1.23	5.79	8.40	10.37	11.22
Discharge (cfs)	**0.0**	**6.3**	**370.2**	**1097.6**	**2130.7**	**2757.8**
Diversion Discharge (cfs)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**177.6**
Total Discharge (cfs)	**0.0**	**6.3**	**370.2**	**1097.6**	**2130.7**	**2935.4**
Storage Area (acres)	**0.04816**	**0.2980**	**1.5231**	**4.0556**	**4.0556**	**4.0556**

WLB flow (cfs) 4442
Calculated flow at spilling elevation (cfs) 2130
Model Diversion? Yes

Sheet 1 of 3

Sheet 2 of 3

↑N



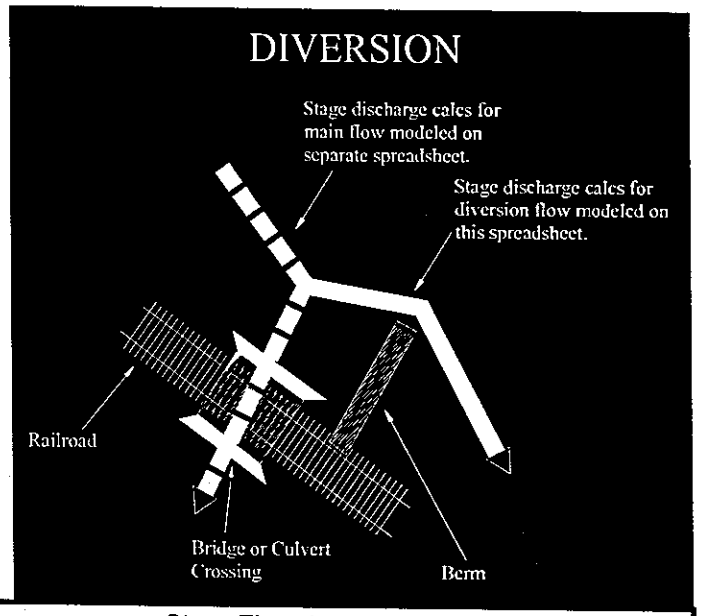
RR 520

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix B-7.2

Entellus ID RR520 Diversion
Station 158+80
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1650
Upstream Channel Bottom (ft)	1652
Distance between upstream and down (ft)	210
Top Elevation (ft)	1654
Top Width (ft)	187
Side Slope, Lt, Z:1	0.027972028
Roughness "n"	0.035
Bottom Width (ft)	44
Bottom Slope, (ft/ft)	0.009524

Sketch



	Stage Elevation				
	1652	**1653**	**1654**	**1655**	**1656**
Rt Side Slope length (ft)	0.00	1.00	2.00	3.00	4.00
Flow Depth, (ft)	0.00	1.00	2.00	3.00	4.00
X-S Area (sqft)	0.0	44.0	88.1	132.3	176.4
Perimeter, (ft)	44.0	46.0	48.0	50.0	52.0
Hyd. Radius, (ft)	0.00	0.96	1.84	2.64	3.39
Velocity, (fps)	#DIV/0!	4.03	6.23	7.95	9.38
Diversion Discharge (cfs)	**0.0**	**177.6**	**548.8**	**1050.8**	**1655.2**

Sheet 3 of 3.

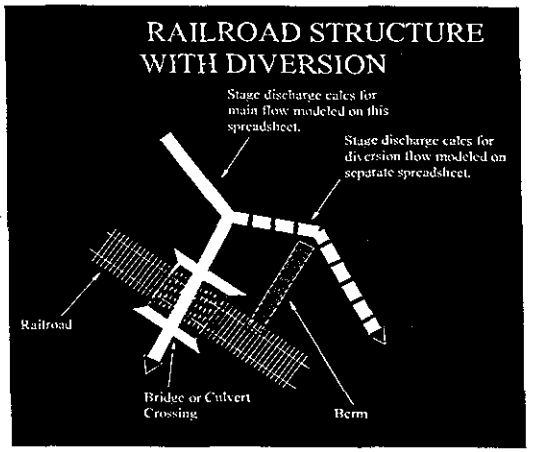
RR540

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5

Entellus ID RR540
Station 160+90
Description 9 - 14' x 7' Concrete Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1560
Downstream Channel Invert Elevation (ft)	1558
Bridge Invert Elevation (ft)	1557.3
Downstream Station (ft)	253
Spilling Stage Elevation (ft)	1562
Average Space Between Pilings (ft)	14
Number of Pilings (ft)	8
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	0
Side Slope, Lt, Z:1	1.33
Roughness "n"	0.035
Bottom Width (ft)	114
Clogging Factor (ft)	12
Adjusted Bottom Width (ft)	102
Bottom Slope, (ft/ft)	0.007905

Sketch



	Stage Elevation				
	1557.3	**1560**	**1562**	**1562.5**	**1563**
Rt Side Slope length (ft)	0.00	2.70	4.70	5.20	5.70
Lt Side Slope length (ft)	0.00	4.49	7.82	8.65	9.48
Flow Depth, (ft)	0.00	2.70	4.70	5.20	5.70
X-S Area (sqft)	0.0	285.1	508.8	566.4	624.6
Perimeter, (ft)	102.0	109.2	114.5	115.9	117.2
Hyd. Radius, (ft)	0.00	2.61	4.44	4.89	5.33
Velocity, (fps)	#DIV/0!	7.18	10.23	10.90	11.55
Discharge (cfs)	**0.0**	**2046.1**	**5204.3**	**6174.9**	**7214.0**
Diversion Discharge (cfs)	**0**	**0**	**0**	**34.8**	**108.0**
Total Discharge (cfs)	**0.0**	**2046.1**	**5204.3**	**6209.6**	**7322.0**
Storage Area (acres)	**0.0581**	**0.4810**	**1.0880**	**1.088**	**1.088**

WLB flow (cfs) 4474
Calculated flow at spilling elevation (cfs) 5204
Model Diversion? Yes

Note: Further review revealed that significant diversion is not likely at this structure, see memo-3-31-4 for details

Sheet 1 of 3

Sheet 2 of 3

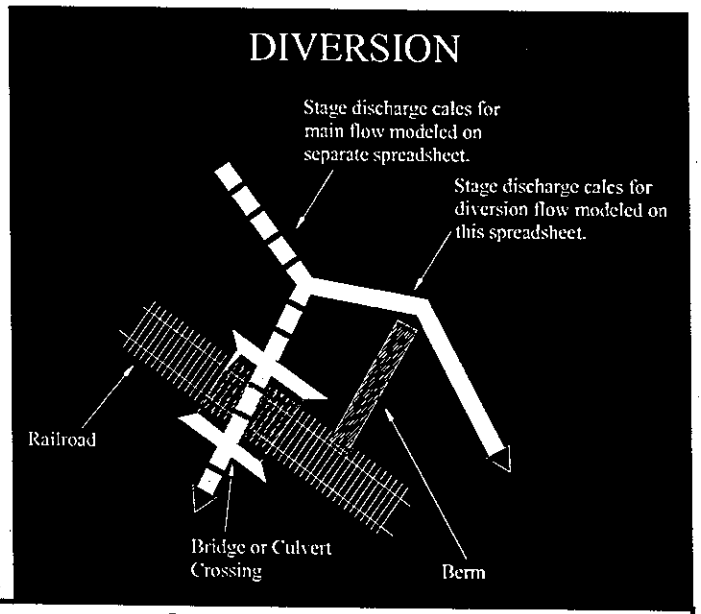
UBR 540

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5

Entellus ID RR540 Diversion
Station 160+90
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1560
Upstream Channel Bottom (ft)	1562
Distance between upstream and down (ft)	150
Top Elevation (ft)	1564
Top Width (ft)	52
Side Slope, Lt, Z:1	0.137931034
Roughness "n"	0.035
Bottom Width (ft)	23
Bottom Slope, (ft/ft)	0.013333

Sketch



	Stage Elevation				
	1562	**1562.5**	**1563**	**1563.5**	**1564**
Rt Side Slope length (ft)	0.00	0.50	1.01	1.51	2.02
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	11.5	23.1	34.8	46.6
Perimeter, (ft)	23.0	24.0	25.0	26.0	27.0
Hyd. Radius, (ft)	0.00	0.48	0.92	1.34	1.72
Velocity, (fps)	#DIV/0!	3.02	4.67	5.97	7.06
Diversion Discharge (cfs)	**0.0**	**34.8**	**108.0**	**207.7**	**328.7**

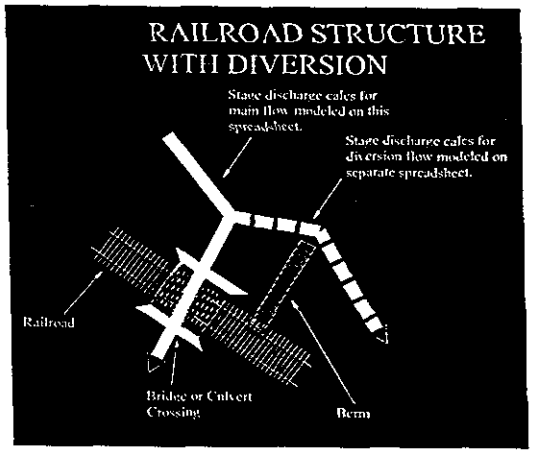
Sheet 3 of 3

RR580

Entellus ID RR580
Station 161+80
Description 1 - 17' x 6' Concrete Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1523.4
Downstream Channel Invert Elevation (ft)	1522.8
Bridge Invert Elevation (ft)	1523.4
Downstream Station (ft)	39
Spilling Stage Elevation (ft)	1526
Average Space Between Pilings (ft)	0
Number of Pilings (ft)	0
Width of Pilings (ft)	0
Side Slope, Rt, Z:1	2
Side Slope, Lt, Z:1	2
Roughness "n"	0.035
Bottom Width (ft)	16.8
Clogging Factor (ft)	0
Adjusted Bottom Width (ft)	16.8
Bottom Slope, (ft/ft)	0.015385

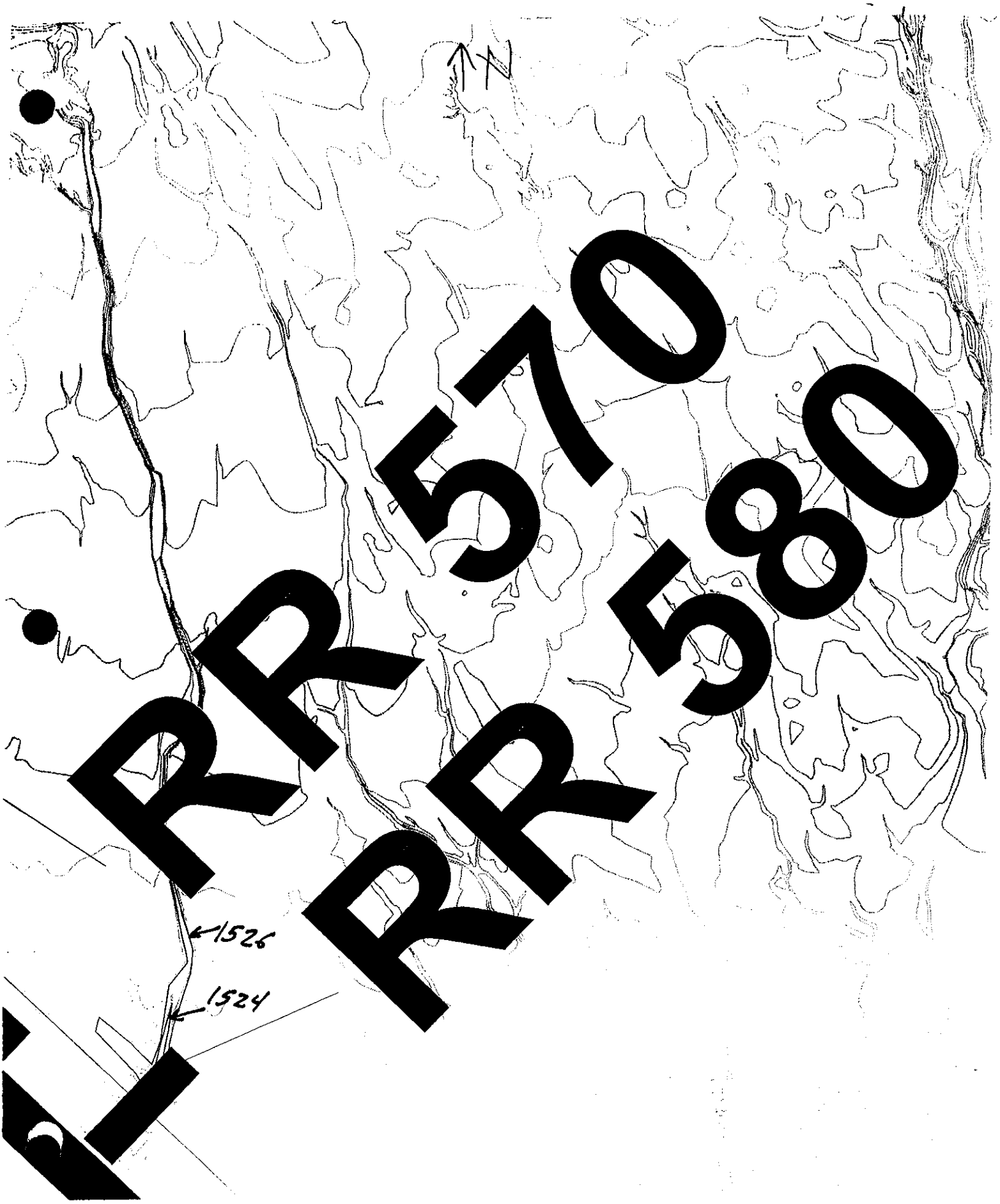
Sketch



	Stage Elevation				
	1523.4	**1524**	**1526**	**1526.5**	**1530**
Rt Side Slope length (ft)	0.00	1.34	5.81	6.93	14.76
Lt Side Slope length (ft)	0.00	1.34	5.81	6.93	14.76
Flow Depth, (ft)	0.00	0.60	2.60	3.10	6.60
X-S Area (sqft)	0.0	10.8	57.2	71.3	198.0
Perimeter, (ft)	16.8	19.5	28.4	30.7	46.3
Hyd. Radius, (ft)	0.00	0.55	2.01	2.33	4.27
Velocity, (fps)	#DIV/0!	3.56	8.42	9.27	13.91
Discharge (cfs)	**0.0**	**38.5**	**481.4**	**660.8**	**2753.9**
Diversion Discharge (cfs)	**0.0**	**0.0**	**0.0**	**218.2**	**8008.2**
Total Discharge (cfs)	**0.0**	**38.5**	**481.4**	**879.0**	**10762.1**
Storage Area (acres)	**0**	**0.0401**	**0.3196**	**0.3196**	**0.3196**

WLB flow (cfs) 330
Calculated flow at spilling elevation (cfs) 481
Model Diversion? Yes

Sheet 1 of 3



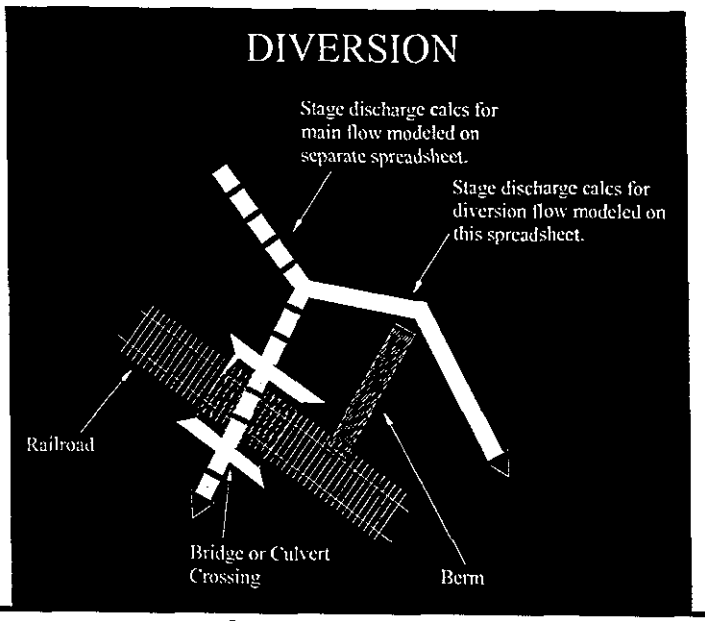
RR 570
RR 580

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D.3.2

Entellus ID RR580 Diversion
Station 161+80
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1524
Upstream Channel Bottom (ft)	1526
Distance between upstream and down (ft)	140
Top Elevation (ft)	1532.14
Top Width (ft)	135
Side Slope, Lt, Z:1	12.28
Roughness "n"	0.035
Bottom Width (ft)	134
Bottom Slope, (ft/ft)	0.014286

Sketch



	Stage Elevation					
	1526	**1526.5**	**1527**	**1527.5**	**1528**	**1530**
Rt Side Slope length (ft)	0.00	6.16	12.32	18.48	24.64	49.28
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00	4.00
X-S Area (sqft)	0.0	70.1	146.3	228.6	317.1	732.5
Perimeter, (ft)	134.0	146.3	158.6	171.0	183.3	232.6
Hyd. Radius, (ft)	0.00	0.48	0.92	1.34	1.73	3.15
Velocity, (fps)	#DIV/0!	3.11	4.82	6.18	7.33	10.93
Diversion Discharge (cfs)	**0.0**	**218.2**	**705.1**	**1412.1**	**2325.6**	**8008.2**

Sheet 3 of 3

RR600 and RR610

Entellus™

SHEET 1 OF 8

BY [illegible] DATE 4/5/4

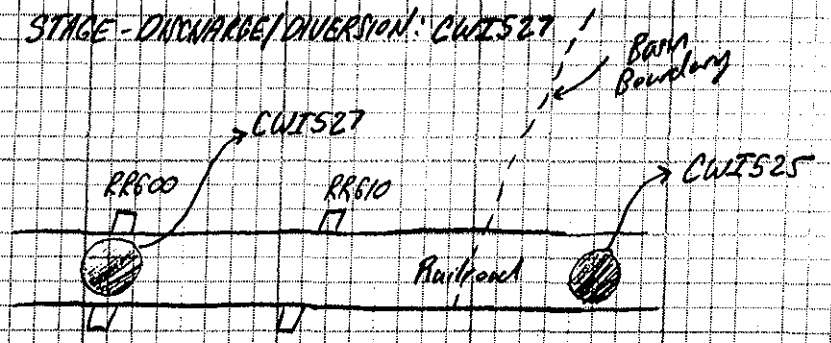
CHECK CJL DATE 4/12/4

CLIENT FCD

JOB NAME Wittmann ADMSD

JOB NO. 310032

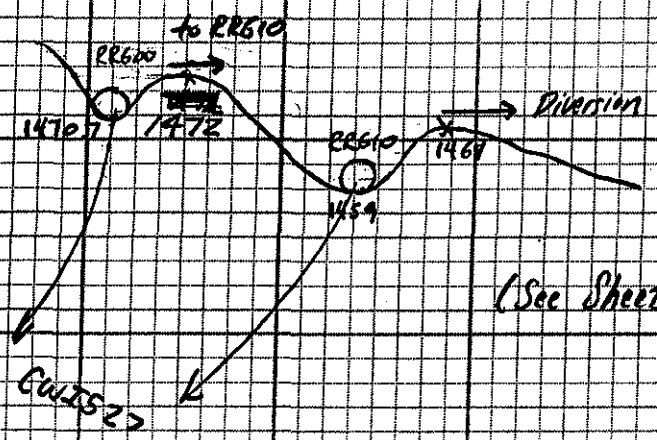
STAGE-DISCHARGE/DIVERSION: CWI527



RR600: 2-13'x7' Bridge, invert @ 1470.7

RR610: 2-48" RCP, invert @ 1459.9

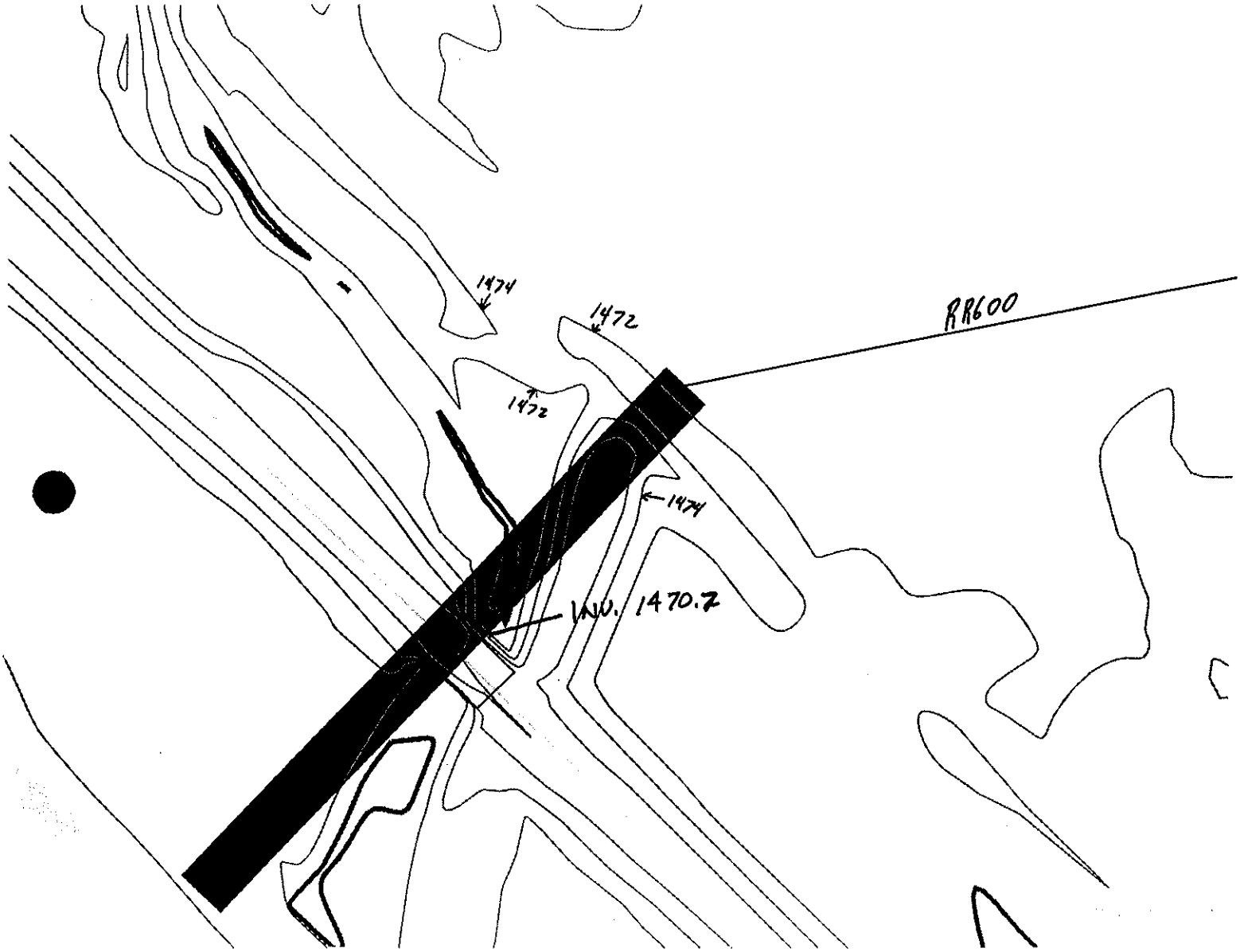
Preliminary Q @ CWI527 = 553

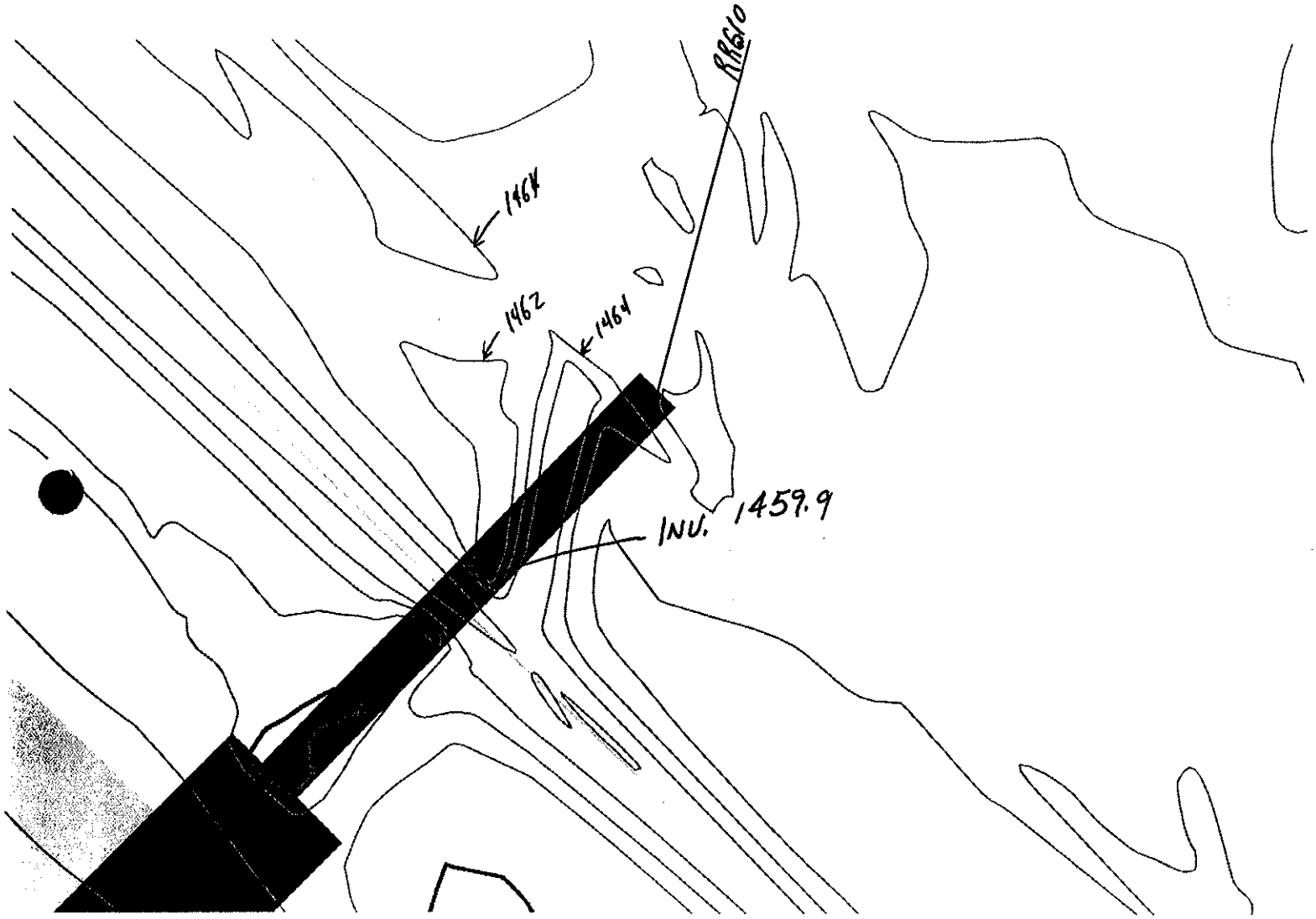


(See Sheets 2 & 3 for topo)

RR600		RR610			Diversion	
Q	E	Q	H/D	E	Q	E
0	1470.7	-	-			
144	1472	-	-			
248	1472.5	-	-			
375	1473	-	-			
524	1473.5	-	-			
695	1474	-	-	1459		
695	1474	17	.75	1462		
695	1474	95	1.25	1464	0	1464
695	1474	130	1.75	1466	451	1466
695	1474	160	2.25	1468	1351	1468
695	1474	180	2.75	1470	2518	1470

See next page.


1474
1472
1472
1474
RR600
INV. 1470.7


RR610
1464
1462
1464
INV. 1459.9

Entellus™

BY _____ DATE _____

CHECK _____ DATE _____

CLIENT _____

JOB NAME _____ JOB NO. _____

CWI 527 Structure @ RR600 Elev.	Q (cfs)	From RR600 Diversion to RR610 Q	RR610 H/D	RR610 Q	RR610 E	From RR610 Diversion to CWI 527 Q	HEC-1 Data DI	HEC-1 Data DQ
1470.7	0	–					0	0
1472	144	0		0	1459.9		144	0
1472.5	248	47	.5	48	1462	–	295	0
1473	375	148	1.0	150	1464	0	523	0
1473.5	524	287	1.2	185	1464.75	92	811	92
1474	695	459	1.4	205	1465.4	254	1154	254
1476	1600	1400	1.9	280	1467.5	1097	3000	1097

See sheet 5 for calcs.

See sheet 6 for calcs

See sheet 8 for calcs

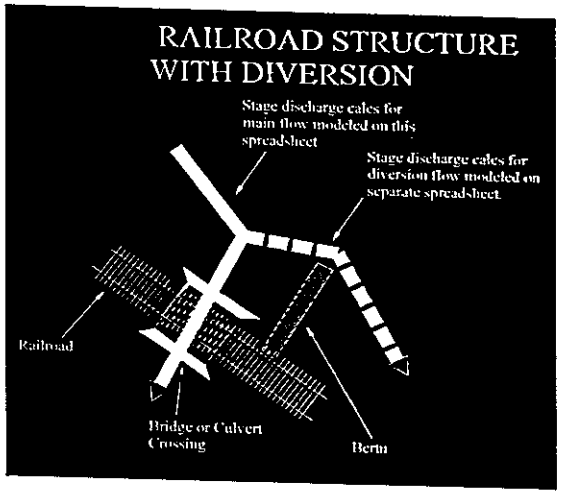
See sheet 7 for calcs

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR600
Station 163+20
Description 2 - 13' x 7' Concrete Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1470.7
Downstream Channel Invert Elevation (ft)	1469.08
Bridge Invert Elevation (ft)	1470.7
Downstream Station (ft)	43.6
Spilling Stage Elevation (ft)	~~1474~~ 1472
Average Space Between Pilings (ft)	8
Number of Pilings (ft)	2
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	1.23
Side Slope, Lt, Z:1	1
Roughness "n"	0.035
Bottom Width (ft)	14.5
Clogging Factor (ft)	3
Adjusted Bottom Width (ft)	11.5
Bottom Slope, (ft/ft)	0.037156

Sketch



	Stage Elevation					
	1470.7	1472	1472.5	1473	1473.5	1474
Rt Side Slope length (ft)	0.00	2.06	2.85	3.65	4.44	5.23
Lt Side Slope length (ft)	0.00	1.84	2.55	3.25	3.96	4.67
Flow Depth, (ft)	0.00	1.30	1.80	2.30	2.80	3.30
X-S Area (sqft)	0.0	16.6	23.9	31.7	40.0	48.8
Perimeter, (ft)	11.5	15.4	16.9	18.4	19.9	21.4
Hyd. Radius, (ft)	0.00	1.08	1.42	1.73	2.01	2.28
Velocity, (fps)	#DIV/0!	8.64	10.35	11.80	13.08	14.23
Discharge (cfs)	0.0	143.8	247.8	374.6	523.7	694.8

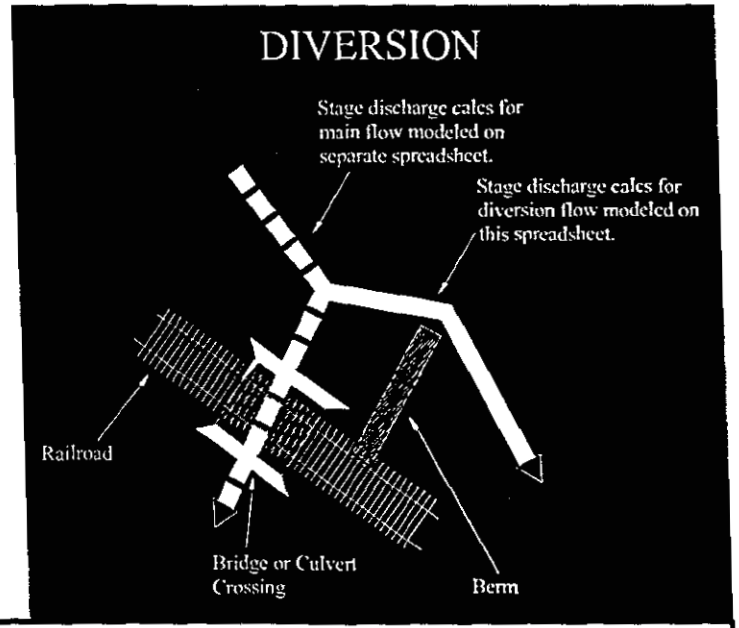
WLB flow (cfs) 321
Calculated flow at spilling elevation (cfs) 144
Model Diversion? Yes

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR600 Diversion
Station 163+20
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1470
Upstream Channel Bottom (ft)	1472
Distance between upstream and down (ft)	253
Top Elevation (ft)	1474
Top Width (ft)	57 0.2
Side Slope, Lt, Z:1	~~0.235294118~~
Roughness "n"	0.035
Bottom Width (ft)	40
Bottom Slope, (ft/ft)	0.007905

Sketch



	Stage Elevation					
	1472	**1472.5**	**1473**	**1473.5**	**1474**	**1476**
Rt Side Slope length (ft)	0.00	0.51	1.03	1.54	2.05	4.11
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00	4.00
X-S Area (sqft)	0.0	20.1	40.2	60.5	80.9	163.8
Perimeter, (ft)	40.0	41.0	42.1	43.1	44.1	48.2
Hyd. Radius, (ft)	0.00	0.49	0.96	1.40	1.84	3.40
Velocity, (fps)	#DIV/0!	2.35	3.68	4.75	5.67	8.55
Diversion Discharge (cfs)	**0.0**	**47.1**	**147.9**	**287.4**	**459.2**	**1400.5**

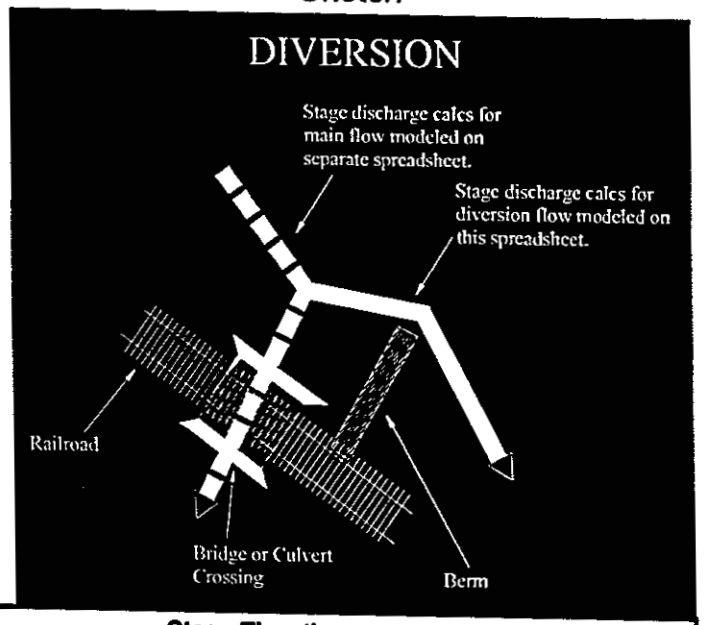
8.70

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix

Entellus ID RR610 Diversion to WI525
Station 163+5
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1462
Upstream Channel Bottom (ft)	1464
Distance between upstream and down (ft)	253
Top Elevation (ft)	1464
Top Width (ft)	57
Side Slope, Lt, Z:1	0
Roughness "n"	0.035
Bottom Width (ft)	40
Bottom Slope, (ft/ft)	0.007905

Sketch

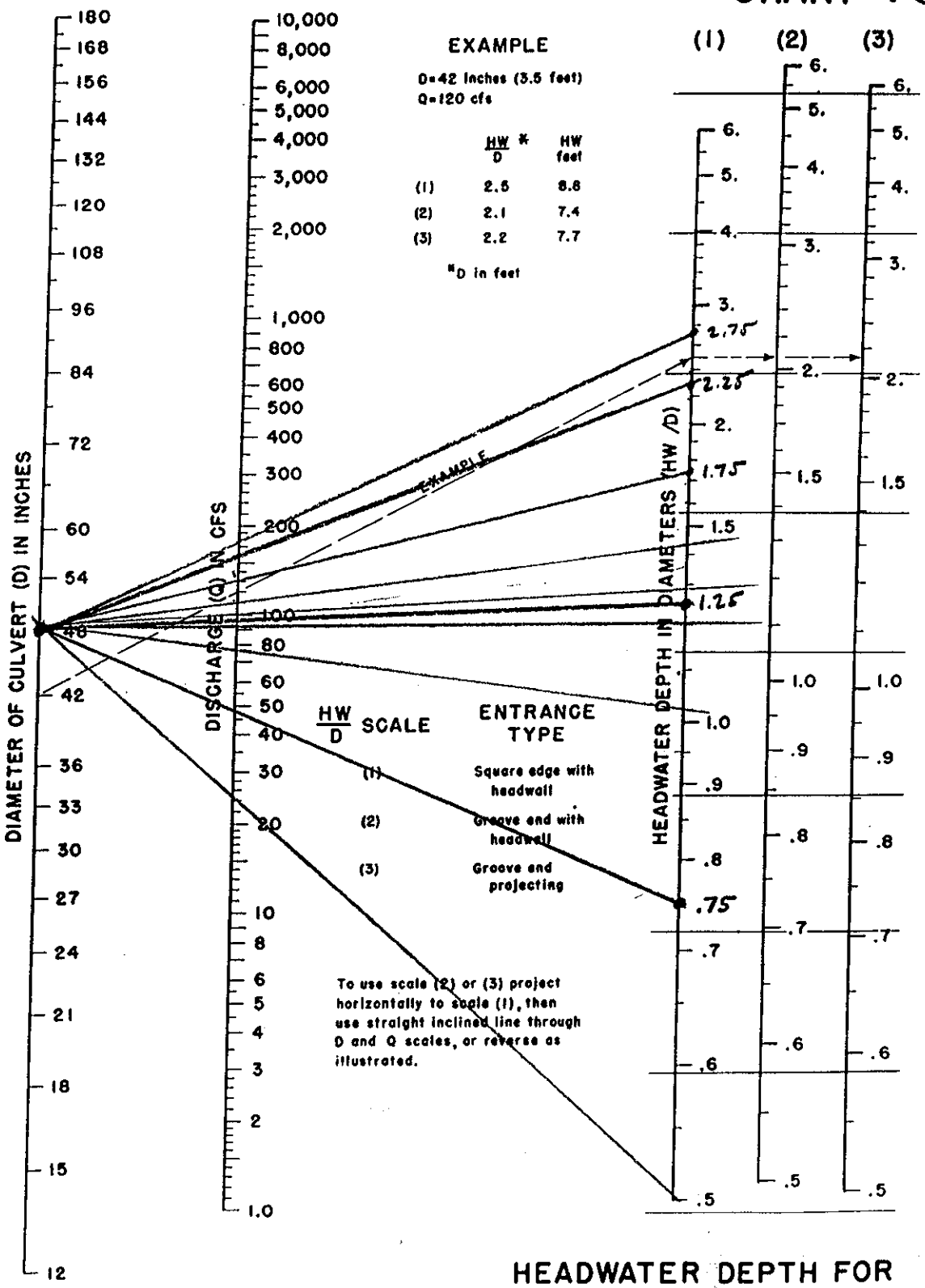


	Stage Elevation				
	1464	**1464.75**	**1465.4**	**1467.5**	
Rt Side Slope length (ft)	0.00	0.75	1.40	3.50	
Flow Depth, (ft)	0.00	0.75	1.40	3.50	
X-S Area (sqft)	0.0	30.0	56.0	140.0	
Perimeter, (ft)	40.0	41.5	42.8	47.0	
Hyd. Radius, (ft)	0.00	0.72	1.31	2.98	
Velocity, (fps)	#DIV/0!	3.05	4.53	7.84	
Diversion Discharge (cfs)	**0.0**	**91.5**	**253.6**	**1097.0**	

Sheet 1 of 8

RR610
CWI527

CHART 1



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

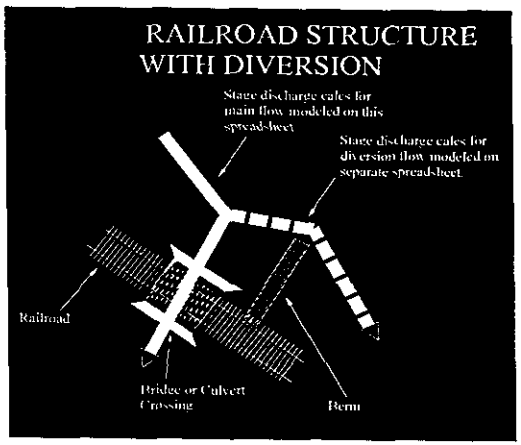
RR630

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5-2

Entelius ID RR630
Station 164+50
Description 4 - 14' x 6' Wooden Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1420.68
Downstream Channel Invert Elevation (ft)	1420.45
Bridge Invert Elevation (ft)	1420.68
Downstream Station (ft)	36
Spilling Stage Elevation (ft)	1422
Average Space Between Pilings (ft)	14
Number of Pilings (ft)	3
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	0
Side Slope, Lt, Z:1	0
Roughness "n"	0.035
Bottom Width (ft)	56
Clogging Factor (ft)	4.5
Adjusted Bottom Width (ft)	51.5
Bottom Slope, (ft/ft)	0.006389

Sketch

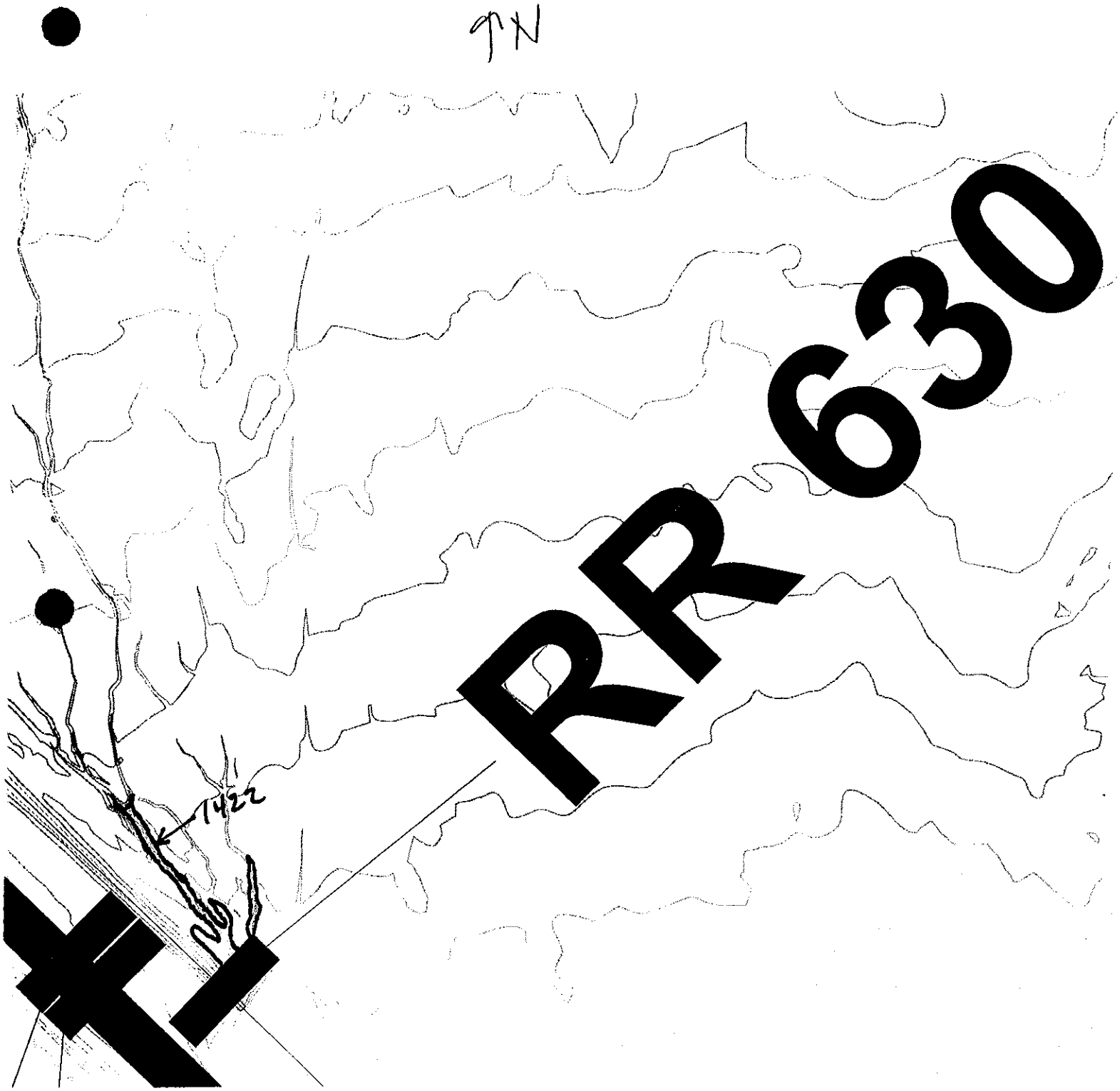


	Stage Elevation				
	1420.68	**1422**	**1422.5**	**1423**	**1423.5**
Rt Side Slope length (ft)	0.00	1.32	1.82	2.32	2.82
Lt Side Slope length (ft)	0.00	1.32	1.82	2.32	2.82
Flow Depth, (ft)	0.00	1.32	1.82	2.32	2.82
X-S Area (sqft)	0.0	68.0	93.7	119.5	145.2
Perimeter, (ft)	51.5	54.1	55.1	56.1	57.1
Hyd. Radius, (ft)	0.00	1.26	1.70	2.13	2.54
Velocity, (fps)	#DIV/0!	3.96	4.85	5.63	6.34
Discharge (cfs)	**0.0**	**269.2**	**454.3**	**672.7**	**920.4**
Diversion Discharge (cfs)	**0.0**	**0.0**	**8.9**	**26.3**	**48.4**
Total Discharge (cfs)	**0.0**	**269.2**	**463.2**	**699.0**	**968.8**
Storage Area (acres)	**0.0786**	**1.3031**	**1.3031**	**1.3031**	**1.3031**

WLB flow (cfs) 786
Calculated flow at spilling elevation (cfs) 269
Model Diversion? Yes

Sheet 1 of 3

Sheet 2 of 3



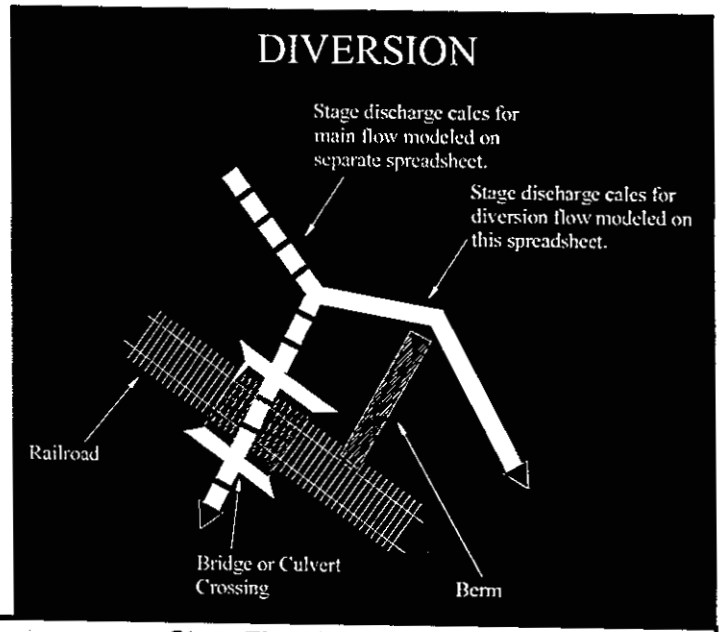
RR 630

Wittmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-7

Entellus ID RR630 Diversion
Station 164+50
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1420
Upstream Channel Bottom (ft)	1422
Distance between upstream and down (ft)	216
Top Elevation (ft)	1424
Top Width (ft)	383
Side Slope, Lt, Z:1	0.010652463
Roughness "n"	0.035
Bottom Width (ft)	7.5
Bottom Slope, (ft/ft)	0.009259

Sketch



	Stage Elevation				
	1422	**1422.5**	**1423**	**1423.5**	**1424**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	3.8	7.5	11.3	15.0
Perimeter, (ft)	7.5	8.5	9.5	10.5	11.5
Hyd. Radius, (ft)	0.00	0.44	0.79	1.07	1.31
Velocity, (fps)	#DIV/0!	2.38	3.50	4.30	4.90
Diversion Discharge (cfs)	**0.0**	**8.9**	**26.3**	**48.4**	**73.7**

Sheet 3 of 3

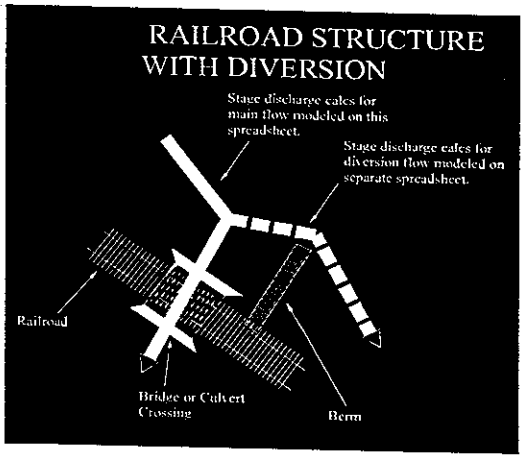
RR650

Willmann Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 60 Railroad Structures
Appendix D-5

Entelius ID RR650
Station 165+70
Description 6 - 14' x 8' Wooden Bridge

Manning's Normal Depth Input	
Upstream Channel Invert Elevation (ft)	1382
Downstream Channel Invert Elevation (ft)	1380
Bridge Invert Elevation (ft)	1378.09
Downstream Station (ft)	336
Spilling Stage Elevation (ft)	1380
Average Space Between Pilings (ft)	14
Number of Pilings (ft)	4
Width of Pilings (ft)	1
Side Slope, Rt, Z:1	0
Side Slope, Lt, Z:1	0
Roughness "n"	0.035
Bottom Width (ft)	70
Clogging Factor (ft)	6
Adjusted Bottom Width (ft)	64
Bottom Slope, (ft/ft)	0.005952

Sketch

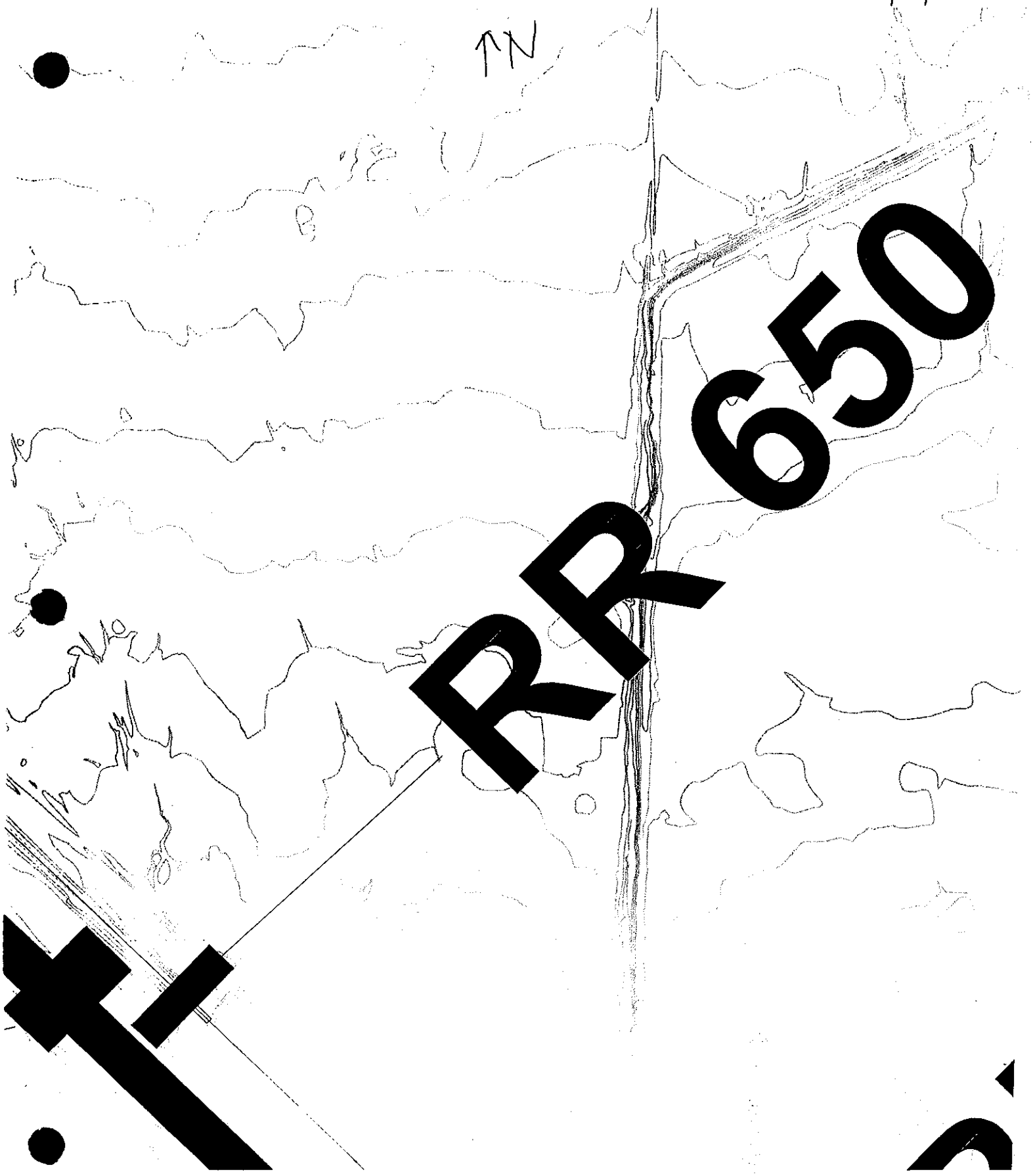


	Stage Elevation				
	1378.09	**1380**	**1380.5**	**1381**	**1381.5**
Rt Side Slope length (ft)	0.00	1.91	2.41	2.91	3.41
Lt Side Slope length (ft)	0.00	1.91	2.41	2.91	3.41
Flow Depth, (ft)	0.00	1.91	2.41	2.91	3.41
X-S Area (sqft)	0.0	122.2	154.2	186.2	218.2
Perimeter, (ft)	64.0	67.8	68.8	69.8	70.8
Hyd. Radius, (ft)	0.00	1.80	2.24	2.67	3.08
Velocity, (fps)	#DIV/0!	4.86	5.62	6.32	6.96
Discharge (cfs)	**0.0**	**594.6**	**867.6**	**1176.5**	**1517.9**
Diversion Discharge (cfs)	**0.0**	**0.0**	**37.9**	**118.6**	**230.0**
Total Discharge (cfs)	**0.0**	**594.6**	**905.5**	**1295.1**	**1747.9**
Storage Area (acres)	**0**	**0.0918**	**0.0918**	**0.0918**	**0.0918**

WLB flow (cfs) 614
Calculated flow at spilling elevation (cfs) 594
Model Diversion? Yes

Sheet 1 of 3

Sheet 2 of 3



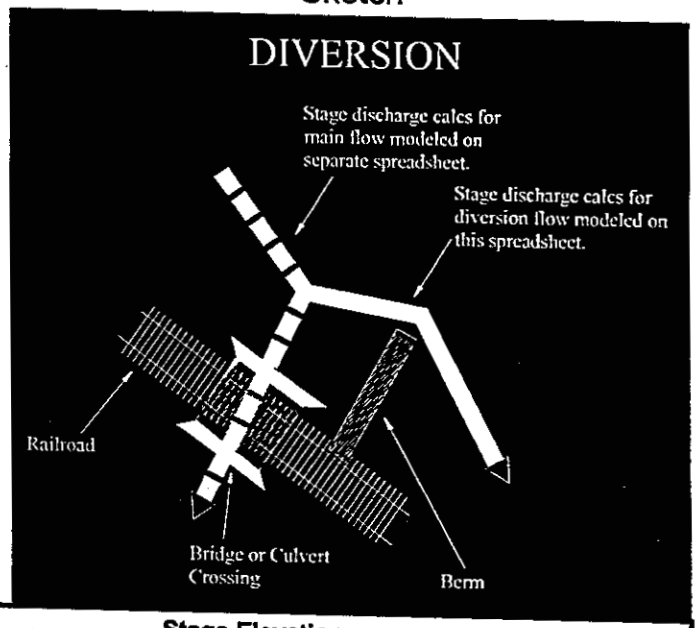
RR 650

Wilmington Area Drainage Master Study Update
Stage vs Discharge Calculations for Hwy 68 Railroad Structures
Appendix [illegible]

Entellus ID RR650 Diversion
Station 165+70
Description Diversion along Railroad

Manning's Normal Depth Input	
Downstream Channel Bottom (ft)	1378
Upstream Channel Bottom (ft)	1380
Distance between upstream and down (ft)	450
Top Elevation (ft)	1382
Top Width (ft)	121
Side Slope, Lt, Z:1	0.051282051
Roughness "n"	0.035
Bottom Width (ft)	43
Bottom Slope, (ft/ft)	0.004444

Sketch



	Stage Elevation				
	1380	**1380.5**	**1381**	**1381.5**	**1382**
Rt Side Slope length (ft)	0.00	0.50	1.00	1.50	2.00
Flow Depth, (ft)	0.00	0.50	1.00	1.50	2.00
X-S Area (sqft)	0.0	21.5	43.1	64.6	86.2
Perimeter, (ft)	43.0	44.0	45.0	46.0	47.0
Hyd. Radius, (ft)	0.00	0.49	0.96	1.40	1.83
Velocity, (fps)	#DIV/0!	1.76	2.76	3.56	4.25
Diversion Discharge (cfs)	**0.0**	**37.9**	**118.6**	**230.0**	**366.6**

Sheet 3 of 3