APPENDIX C

WETLAND DATA FORMS

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton		Date:	May 28, 2008
Applicant/Owner:	Abengoa		County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)		State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes	☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes	☐No	Transect ID:	
Is the area a potential Problem Area?	☒Yes	☐No	Plot ID:	W-1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: Bare soil - less than 5% vegetation cover. Tilled and planted this spring to corn that did not sprout. Ponding, herbicide use, and tillage prevent establishment of vegetation. Wetland vegetation would be present if tillage and direct herbicide application stopped.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)

Depth to Free Water in Pit: ______ (in.)

Depth to Saturated Soil: ______ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☒ Drift Lines
- ☒ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☒ Other (Explain in Remarks)

Remarks: Lowest elevation in field. Ponding observed in 2004 and 2005 aerial photographs.

SOILS

Map Unit Name
(Series and Phase): Canina loam

Drainage Class: ______
Field Observations
Confirm Mapped Type? ☐ Yes ☐ No

Taxonomy (Subgroup): ______

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 2		7.5YR 3/2			dry sandy loam
2 - 10		10YR 3/2			moist loam
10 - 18		7.5YR 3/2 &	7.5YR 2.5/1	few small soft	very moist loam &
		10YR 5/6		concretions & organic streaking	silty sand

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☒ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☒ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☒ Other (Explain in Remarks)

Remarks: Disturbed and mixed soil. Soil has been disturbed by the following : 55+ years of tillage for crop production; approximately 35 years ago a flood irrigation return water pond was constucted by excavating about 5 feet of soil; and, construction of a berm for the center pivot irrigation and approximately 4 feet of filling 3 years ago.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No (Check)
Wetland Hydrology Present? ☒ Yes ☐ No
Hydric Soils Present? ☒ Yes ☐ No

(Check)
Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

Remarks 0.27 acre of isolated non-jurisdictional farmed wetland. Note: Data point W-3 is also in this wetland.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton	Date:	May 28, 2008
Applicant/Owner:	Abengoa	County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)	State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes ☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes ☐No	Transect ID:	
Is the area a potential Problem Area?	☒Yes ☐No	Plot ID:	W-2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Echinochloa crusgalli		FACW	9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 1/1

Remarks: 95% vegetation cover. Tilled and planted this spring to corn.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)

Depth to Free Water in Pit: ______ (in.)

Depth to Saturated Soil: ______ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☒ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☒ Other (Explain in Remarks)

Remarks: Ponding observed in 2004 and 2005 aerial photographs.

SOILS

Map Unit Name (Series and Phase): Canina loam

Drainage Class:

Field Observations Confirm Mapped Type? ☐ Yes ☐ No

Taxonomy (Subgroup):

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 2		10YR 4/2			dry sandy loam
2 - 12		10YR 3/3			very moist clay loam
12 - 18		10YR 2/2	10YR 3/1 clay & 10YR 6/6 sand	few coarse	very moist mixed sandy & clayey loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☒ Other (Explain in Remarks)

Remarks: Disturbed and mixed soil. Soil has been disturbed by the following : 55+ years of tillage for crop production; approximately 35 years ago a flood irrigation return water pond was constucted by excavating about 5 feet of soil; and, construction of a berm for the center pivot irrigation and approximately 4 feet of filling 3 years ago.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No (Check)

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

(Check)

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

Remarks 0.16 acre of isolated non-jurisdictional farmed wetland.

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton	Date:	May 29, 2008
Applicant/Owner:	Abengoa	County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)	State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes ☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes ☐No	Transect ID:	
Is the area a potential Problem Area?	☒Yes ☐No	Plot ID:	W-3

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Echinochloa crusgalli		FACW	9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 1/1

Remarks: 95% vegetation cover. Tilled and planted this spring to corn.

HYDROLOGY

- ☐ Recorded Data (Describe in Remarks):
  - ☐ Stream, Lake, or Tide Gauge
  - ☒ Aerial Photographs
  - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)

Depth to Free Water in Pit: ______ (in.)

Depth to Saturated Soil: ______ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☒ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☒ Other (Explain in Remarks)

Remarks: Ponding observed in 2004 and 2005 aerial photographs.

SOILS

Map Unit Name
(Series and Phase): Canina loam

Drainage Class: ______

Field Observations
Confirm Mapped Type? ☐ Yes ☐ No

Taxonomy (Subgroup): ______

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 4		10YR 3/2			dry sandy loam
4 - 8		10YR 3/3 &			moist loam
		7.5 YR 6/4			
8 - 18		10YR 3/2 &			very moist loam
		2.5Y 2.5/1			

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☒ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☒ Other (Explain in Remarks)

Remarks: Polychromatic matrix. Disturbed and mixed soil. Soil has been disturbed by the following : 55+ years of tillage for crop production; approximately 35 years ago a flood irrigation return water pond was constucted by excavating about 5 feet of soil; and, construction of a berm for the center pivot irrigation and approximately 4 feet of filling 3 years ago.

WETLAND DETERMINATION

	(Check)	
Hydrophytic Vegetation Present?	☒ Yes	☐ No
Wetland Hydrology Present?	☒ Yes	☐ No
Hydric Soils Present?	☒ Yes	☐ No

Is this Sampling Point Within a Wetland? (Check) ☒ Yes ☐ No

Remarks Second data point in isolated non-jurisdictional farmed Wetland "W-1".

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton	Date:	May 29, 2008
Applicant/Owner:	Abengoa	County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)	State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes ☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes ☐No	Transect ID:	
Is the area a potential Problem Area?	☐Yes ☒No	Plot ID:	W-4

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: 4-8 inch tall corn planted in rows. Coverage of vegetation other than corn less than 5%.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ________ (in.)

Depth to Free Water in Pit: ________ (in.)

Depth to Saturated Soil: ________ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Upland

SOILS

Map Unit Name (Series and Phase):	Canina loam	Drainage Class:	
		Field Observations Confirm Mapped Type?	☐ Yes ☐ No
Taxonomy (Subgroup):			

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 10		10YR 3/3			moist loam
10 - 18		10YR 3/2 &			moist loam
		5YR 6/4			

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Disturbed and mixed soil. Soil has been disturbed by the following : 55+ years of tillage for crop production; approximately 35 years ago a flood irrigation return water pond was constucted by excavating about 5 feet of soil; and, construction of a berm for the center pivot irrigation and approximately 4 feet of filling 3 years ago.

WETLAND DETERMINATION

			(Check)
Hydrophytic Vegetation Present?	☐ Yes ☒ No	(Check)	
Wetland Hydrology Present?	☐ Yes ☒ No		
Hydric Soils Present?	☐ Yes ☒ No	Is this Sampling Point Within a Wetland?	☐ Yes ☒ No

Remarks

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DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton	Date:	May 29, 2008
Applicant/Owner:	Abengoa	County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)	State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes ☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes ☐No	Transect ID:	
Is the area a potential Problem Area?	☐Yes ☒No	Plot ID:	W-5

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: 4-8 inch tall corn planted in rows. Coverage of vegetation other than corn less than 5%.

HYDROLOGY

☐ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ________ (in.)

Depth to Free Water in Pit: ________ (in.)

Depth to Saturated Soil: ________ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Upland

SOILS

Map Unit Name
(Series and Phase): Canina loam

Drainage Class:

Field Observations

Taxonomy (Subgroup):

Confirm Mapped Type? ☐ Yes ☐ No

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 8		10YR 4/2			moist loam
8 -18		10YR 2/2 &			moist clay loam
		7.5YR 4/4			

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Disturbed soil. Some vertical and horizontal sand lens.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No (Check)
Wetland Hydrology Present? ☐ Yes ☒ No
Hydric Soils Present? ☐ Yes ☒ No

(Check)
Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

Remarks

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton	Date:	May 29, 2008
Applicant/Owner:	Abengoa	County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)	State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes ☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes ☐No	Transect ID:	
Is the area a potential Problem Area?	☐Yes ☒No	Plot ID:	W-6

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: 4-8 inch tall corn planted in rows. Coverage of vegetation other than corn less than 5%.

HYDROLOGY

- ☐ Recorded Data (Describe in Remarks):
  - ☐ Stream, Lake, or Tide Gauge
  - ☐ Aerial Photographs
  - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)

Depth to Free Water in Pit: ______ (in.)

Depth to Saturated Soil: ______ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Upland

SOILS

Map Unit Name
(Series and Phase): Canina loam

Drainage Class: ______

Taxonomy (Subgroup): ______

Field Observations
Confirm Mapped Type? ☐ Yes ☐ No

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 9		7.5YR 3/2			moist loam
9 - 18		7.5YR 3/1			moist clay

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Disturbed soil. Soil has been disturbed by the following : 55+ years of tillage for crop production; approximately 35 years ago a flood irrigation return water pond was constucted by excavating about 5 feet of soil; and, construction of a berm for the center pivot irrigation and approximately 4 feet of filling 3 years ago.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	☐ Yes ☒ No (Check)		(Check)
Wetland Hydrology Present?	☐ Yes ☒ No		
Hydric Soils Present?	☒ Yes ☐ No	Is this Sampling Point Within a Wetland?	☐ Yes ☒ No

Remarks

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Hugoton	Date:	May 29, 2008
Applicant/Owner:	Abengoa	County:	Stevens
Investigator:	Kleinfelder (Tom Plattner)	State:	Kansas
Do Normal Circumstances exist on the site?	☐Yes ☒No	Community ID:	
Is the site significantly disturbed (Atypical Situation)?	☒Yes ☐No	Transect ID:	
Is the area a potential Problem Area?	☐Yes ☒No	Plot ID:	W-7

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks: 4-8 inch tall corn planted in rows. Coverage of vegetation other than corn less than 5%.

HYDROLOGY

- ☐ Recorded Data (Describe in Remarks):
  - ☐ Stream, Lake, or Tide Gauge
  - ☐ Aerial Photographs
  - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)

Depth to Free Water in Pit: ______ (in.)

Depth to Saturated Soil: ______ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: Upland

SOILS

Map Unit Name (Series and Phase): Canina loam

Drainage Class: ____

Field Observations Confirm Mapped Type? ☐ Yes ☐ No

Taxonomy (Subgroup): ____

Profile Descriptions:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc,
0 - 9		10YR 4/2			moist clay loam
9 -18		10YR 4/2 &			moist loam
		10YR 4/3			

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Disturbed soil.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	☐ Yes	☒ No	(Check)
Wetland Hydrology Present?	☐ Yes	☒ No	
Hydric Soils Present?	☐ Yes	☒ No	

(Check)

Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

Remarks

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APPENDIX D

HYDROLOGICAL ANALYSIS

TABLE OF CONTENTS

APPENDIX D

Playa Wetland Restoration
Hydrology and Feasibility Analysis

1.0 INTRODUCTION AND LIMITATIONS

1.1 Introduction

The purpose of the following analysis is to determine if wetland restoration within the playa in the NW/4 of Section 17 is feasible. The analysis looks at the proposed wetland restoration from the following perspectives:

- wetland hydrology,
- loss of sellable non-contact wastewater in the summer, and,
- reduction of winter water storage capacity for the ethanol plant.

The analysis needs to answer two primary questions: 1) What is the minimum amount of water in the summer that would be needed to provide for a functioning playa wetland; and, 2) What is the maximum amount of water that could be discharged into the playa in the winter without causing undesirable flooding?

1.2 Assumptions and Analysis Limitations

Playas naturally vary in the amount of water present throughout the year and from year to year based on droughts and periods of increased rainfall. Some variation mimics natural conditions and is considered beneficial. There is little to no demand for irrigation water during the winter months. Little to no irrigation in the summer months would be detrimental to the ecological functioning of the playa wetlands.

With the exception of about 1 to 2 acres in the center of the playa (lowest elevations), the playa currently produces good stands of non-water tolerant row-crops such as corn, sorghum, and wheat. The current center pivot irrigation system will remain and could be used for wetland enhancement. The majority of the quarter section would be converted from annual row-crops to biomass production using perennial crops such as, but not limited to, switch grass.

Runoff and storage volumes were largely based on USGS topographic maps. The USGS 7.5 minute topographical map is 30+ years old, is at 1 inch = 2,000 feet scale, and has 5 feet contour intervals. Also, field conditions have been modified since the publication of the USGS topographical map. While the natural topography of the field has been changed for past flood irrigation and row crop production, the current topography appears to resemble the natural topography in that most, if not all, of the original watershed within Section 17 still drains to the playa.

Infiltration rates and evaporation rates are based on generalized soil map units from the county soil survey and other readily available published references. No computer modeling was used and no detailed hydrological modeling was involved in the calculations.

2.0 SETTING

2.1 Natural Setting

The wetland survey location is situated in an area that is predominantly void of surface drainage channels or streams. A review of USGS 7.5-minute quadrangles for the area does not identify a defined drainage within the proposed site, and the nearest surface drainage feature is not apparent for approximately 3 miles to the east (0.75 miles east of Hugoton); this feature appears as an intermittent drainage (USGS Hugoton Kansas Quadrangle). The nearest identifiable named water course is the Cimarron River, located approximately 11 miles northwest of Hugoton. Surface runoff, to the extent it occurs in the study area, flows into interdunal depressions or playa lakes where it evaporates or percolates downward through the soil.

The Cimarron River passes through the northwestern corner of Stevens County with a main stem gradient of approximately 11 feet per mile (KGS 2005 – Aquifer report). The Cimarron River is described as an intermittent stream in Stevens County and generally flows only after intensive rainfall (NRCS 2005). The Cimarron River and its tributaries drain about 10 percent of the area within Stevens County. The remaining area has no exterior drainage. Water flows into interdunal depressions, or playa lakes, where it evaporates or percolates downward through the soil. Stream dissection in the county is in the stage known as topographic youth (NRCS 2006 – Stevens County Survey).

The average annual precipitation for the study area is 18 inches, of which 15 inches falls as rain from April through October. Two years in ten will have less than 15 inches and more than 21.5 inches of precipitation. The average number of days with 0.10 inch or more of precipitation is 31 and the average snowfall is 10 inches. The heaviest 1-day rainfall during the period of record was 4.5 inches at Hugoton on May 25, 1976. Thunderstorms occur on about 52 days each year, and most occur between May and August (NRCS 2006 – Stevens County Survey).

The mean annual lake evaporation is approximately 60 inches with the mean May – October evaporation being approximately 70 percent of the total (Midwest Plan Service, 1987).

The NRCS Soil Survey of Stevens County, Kansas identified the survey location within soil map unit (SMU) 5205 – Canina loam, 0 to 1 percent slopes. The drainage class is "well drained," the slowest permeability is "moderate" (about 0.57 inch per hour), the flooding hazard is "none," the depth to seasonal zone saturation is "more than 6 feet", and the surface runoff class is "negligible." Other SMUs within the playa watershed within Section 17 include SMU 5210 – Belfon loam, 0 to 1 percent slopes and SMU 1611 – Vorhees find sandy loam, 1 to 3 percent slopes. Both of these soils are also well drained, have moderate permeability, low to negligible runoff, and a water table that is 6 or more feet below the surface. None of the SMUs are flooded. Review of the NRCS Stevens County List of Hydric Soils indicated that none of the SMUs are on the hydric list.

The site lies near the center of the 16-digit hydrologic unit code (HUC) 11040006020060, which encompasses 46.2 square miles. Based on contour analysis using the USGS topographic maps with 5 feet interval contour lines, the potential natural maximum watershed for the subject playa is approximately 5 square miles (3,200 acres).

2.2 Existing Conditions

Based on the USGS topographic map, Figure 6 shows the playa watershed natural eastern boundary. However, field observations indicate that a berm along the east side of the northwest quarter section of Section 17 affectively makes it the playa watershed eastern boundary. Road P and Road 11 (both paved) along the north and west sides of the site, respectively, affectively create berms and isolate the site from offsite drainage (see photograph 37 which represents typical field borders such as roads and railroads that interrupt natural drainage patterns). No culverts were observed along these roads in the vicinity of the site. The railroad track along the southern edge of the survey location is also elevated; however, a series of culverts immediately south of the center pivot hub was observed (see photographs 24 and 25). No other culverts, storm water sewers, or other structures to handle runoff were observed within or around the perimeter of the site.

Based on the current configuration of roads, road drainage ditches, railroad tracks, culverts, and flood irrigation berms, the functional playa watershed for typical precipitation events is the quarter section in which it occurs, approximately 154 acres (excludes 6 acres in southeast corner, south of railroad tracks). Moderately heavy thunderstorms could increase the runoff or functional watershed to include the land south of the railroad tracks for a total area of about 275 acres. Flooding conditions would be needed to increase the playa watershed beyond the approximately 275 acres in the northwest and southwest quarters of Section 17. Water would have to pond and flood over low points in roads adjacent to the north, west, and/or south of Section 17.

The playa soils have been disturbed by leveling for flood irrigation purposes, excavation for flood irrigation water collection, and filling to accommodate to center pivot irrigation wheel traversing. A berm has been created that divides Wetlands 1 and 2 to allow the center pivot tower to traverse through the wetland. Ponding was observed during the wetland survey.

According to the owner, the berm was needed to keep the wheel electric motor above water. This indicates that the adjacent row crops need irrigation at times when there is standing water in the bottom of the playa. Therefore, the existing topography appears to create sufficient runoff and the soil conditions appear to create sufficient storage or ponding to maintain water in the playa well beyond the time in which the adjacent land dries out. By extrapolation, we can conclude that the existing conditions resemble natural conditions, but the degree of resemblance is unknown. Based on these observations, restoration of playa appears feasible without large scale changes in surface topography.

3.0 WATER ANALYSIS

The following discussion is based on limited information and scoping-level assumptions. The numbers generated and used throughout this discussion are not intended for design, but should provide sufficient information to preliminarily evaluate playa restoration as it pertains to water storage capacity and availability issues.

3.1 Storage Capacity

Kleinfelder used a laser level in combination with basic GPS and GIS tools to obtain and analyze topographic information. As shown in Figure 7, the surface area of Wetland 1 is 0.27 acres and the surface area of Wetland 2 is 0.16 acre. Elevation data collected during the survey indicated the identified wetlands were approximately 1 foot deep. Assuming the wetland storage capacity is half the surface area times the depth ($V = \frac{1}{2} Ah$), results in a storage capacity of 0.14 and 0.08 acre-feet for Wetlands 1 and 2, respectively.

Wetlands 1 and 2 are at the bottom of a larger depression. Figure 8 shows contour lines developed from limited elevation data collected during the wetland survey. The contour map revealed a low area at the southwest portion of the upper perimeter of the larger depression. The low area resembles the USGS topographic map 3,110 ft. elevation contour shown on Figure 6. Therefore, the elevation at the southwest corner of the upper perimeter of the larger depression was assumed to be the controlling elevation (3,107 ft.) for storage capacity within the larger depression. Using the contour map created from the field survey data and GIS, the storage volume within the 3,107 ft. contour was estimated to be 2.8 acre-feet.

The area within the 3,110 ft. contour line shown in Figure 6 is approximately 12 acres. The storage capacity between the 3,110 ft. contour and the 3,107 ft. contour is approximately 20.4 acre-feet. According to the USGS topographic map, the entire northwest quarter of Section 17 is within a depression. Figure 3 highlights the approximately 96 acres within the 3,115 ft. contour line. The storage capacity between the 3,115 ft. and 3,110 ft. contours is approximately 294 acre-feet. Summing each storage capacity unit, results in a total storage capacity of approximately 317 acre-feet within the 3,115 ft. contour.

Table 1 below summarizes the storage capacity within the depression. The accuracy of the numbers in the table should be considered accurate only to the degree implied by the methods used to calculate them. The "gallons" column was determined by directly converting from acre-feet.

Table 1. Storage Capacity

Elevation	Water Volume	
	Gallons	Acre-Feet
Wetland 1 + 2	71,682	0.22
3107 Contour	912,321	2.8
3110 Contour	7,559,228	23.2
3115 Contour	103,352,895	317

3.2 Available Water

Available water consists of non-contact wastewater from the plant, precipitation directly into the playa, and runoff into the playa. The center pivot irrigation system would allow irrigation of a 0.5 mile radius circle (126 acres) or to apply water to smaller areas near the center of the playa. Irrigation water could be applied at different rates within the playa to create variable hydrological regimes and habitats.

Abengoa Plant

The plant will reportedly generate non-contact wastewater at a rate of 100 gallons per minute, 24 hours per day, 365 days per year. The non-contact wastewater is suitable for land application. Table 2 summarizes this available water in other units.

Table 2. 100 Gallons Per Minute Equivalents

	Day	**Week**	**Month**	**Year**
Gallons	144,00	1,008,000	4,320,000	52,560,000
Acre-feet	0.44	3.1	13.3	161

The plant has several options for utilization of this water, including:

- Irrigation water for the three center pivots on the east tract
- Selling to the golf course or other nearby land owners
- Playa wetland restoration

Beneficial reuse of the non-contact wastewater will require sufficient storage capacity to accumulate enough water to effectively pump and apply the water. Assuming 0.5 mile diameter center pivots (126 acres), all non-contact wastewater would provide about 15 inches of water for one center pivot, or about 5 inches of water for each of the three center pivots on the east tract.

Neglecting evaporation and infiltration, it would take about one-week's supply of non-contact wastewater to fill the playa to the 3,107 ft. contour, which has a surface area of about 1.8 acres. Assuming 68 inches (5.7 feet) of evapotranspiration per year, and a vertical infiltration rate of 0.05 inches per day (18 inches per year or 1.5 feet per year) for the most restrictive subsurface layer, results in a loss of 86 inches (7.2 feet) per year. At the 3,107 ft. contour (1.8 surface acres), it would take about 13 acre-feet or one-month's supply of non-contact wastewater to offset these yearly losses (not including any direct precipitation and runoff).

Precipitation and Runoff

The average yearly precipitation is about 18 inches. Therefore, precipitation directly onto the permanent pool basically offsets infiltration losses, leaving 68 inches of evapotranspiration loss per year.

Runoff was estimated for two scenarios. The 154-acre watershed applies to the northwest quarter of Section 17 in which the playa is located. The 275-acre watershed includes runoff from Section 17 south of the railroad tracks. Runoff from land outside Section 17 was considered to only occur during flooding and was not reviewed.

The runoff was estimated using the Natural Resources Conservation Service runoff volume method from *Soil and Water Conservation Engineering, Fourth Edition*. The NRCS method was derived from years of storm flow records for agricultural watersheds throughout the United States. The derived equation is:

$$Q = (I - 0.2S)^2 / (I + 0.8S)$$

Where Q = direct surface runoff depth in mm

I = storm rainfall in mm

S = maximum potential difference between rainfall and runoff in mm, starting at the time the storm begins.

For convenience in evaluating antecedent rainfall, soil conditions, land use, and conservation practices, USDS-SCS (1972) defines:

S = (25,400/N) – 254
Where N is an arbitrary curve number varying from 0 to 100

Various storm rainfalls (I) were determined from the National Oceanic & Atmospheric Administration's (NOAA) National Weather Service (NWS) Technical Paper No. 40. A curve number of 75 was selected to represent future land use of biomass production. The design storm and antecedent rainfall conditions greatly affect runoff estimates. Dry soil conditions would be anticipated during the summer and wet soil conditions would be expected during the winter and early spring. Results for different rainfalls and antecedent conditions are attached.

154-acre Watershed: Under average soil moisture conditions (Condition II), a 1.2-inch rain (1-year, 1-hour design storm) would result in about 1 acre-feet of runoff. A 2-inch rain would generate about 5 acre-feet or runoff. Under dry conditions (Condition I), the same storms would generate about 0.06 and 0.7 acre-feet of runoff, respectively. Under wet conditions (Condition III), these storms would generate about 3.7 and 10.6 acre-feet, respectively. Rains around 1-inch and below would likely only result in runoff from the 154-acre field. Under dry conditions, little recharge of the playa would be expected. Under wet conditions, enough runoff to fill the playa above the 3,107 ft. contour could be generated. Rains above 2 inches would likely generate runoff from the land south of the railroad tracks.

275-acre Watershed: Under average soil moisture conditions, a 2-inch rain would generate about 8.7 acre-feet of runoff and a 2.9-inch rain (25-year, 1-hour design storm) would produce about 20 acre-feet of runoff. Therefore, with 3 acre-feet of water in the playa, a 3-inch rain under average soils moisture conditions may fill the playa to the 3,110 ft. contour. Under dry conditions, the same storms would only generate about 1.2 and 6.3 acre-feet of runoff, respectively. Under wet conditions (Condition III), these storms would generate about 19 and 35 acre-feet, respectively. At what point flooding would occur and result in additional runoff from neighboring properties is unknown. For this reason, runoff from rainfalls above 3 inches was not reviewed. However, even constant application of non-contact wastewater to the playa (161 acre-feet yearly supply) in conjunction with a significant rain event (35 acre-feet of runoff) would not likely cause flooding beyond the field in which the playa is located (317 acre-feet of storage capacity).

3.3 Operating Analysis

The application of non-contact wastewater to the playa, biomass fields, nearby crop fields, or the golf course will be an ongoing task of managing the health of the playa, potentially meeting biomass production research objectives, and economics. A simple method to maintain the health of the playa would be to install a staff gauge with a minimum pool marker. A possible exception could be to allow the playa to dry out during summer or drought when natural playas would likely do so. A maximum pool elevation could also be marked on the staff gauge that would mark the water elevation in which no additional non-contact wastewater should be applied, with sufficient freeboard to protect the adjacent biomass field from flooding conditions. To evaluate application of non-contact wastewater to the playa through the center pivot irrigation system, two extremes (winter and summer) and average conditions were reviewed.

Under average conditions, we'll assume the playa has about 3 acre-feet of water (3,107 ft. contour). Without rainfall or non-contact wastewater, the playa would likely not dry out for 3 to 6 months. Without rainfall and with constant application of non-contact wastewater for a month, the playa would contain about 15.7 acre-feet of water (3 acre-feet initial + 13.3 acre-feet of non-contact wastewater – 0.6 acre-feet loss to evapotranspiration and infiltration). Under these conditions (dry), a 3-inch storm would add about 6.5 acre-feet of water, for a total of 22.2 acre-feet. Under these conditions, the playa would still be within the 3,110 ft. contour. Similarly, if the playa contains about 3 acre-feet of water and a significant rainfall occurs (3 inch or less), a month's worth of non-contact wastewater could still be applied and the playa would only encompass about 12 acres (3,110 ft. contour).

During winter, the only way to get rid of non-contact wastewater may be through the three center pivots. However, with 317 acre-feet of storage capacity within the field, the plant could apply all non-contact wastewater to the field and not flood beyond the field. Ideally, the water level in the playa would be relatively low entering winter and could hold about 1.5 month's worth of non-contact wastewater within the 3,110 ft. contour. The plant would also have the option of applying water through the other two center pivots.

The non-contact wastewater will be in high demand during the summer. As described previously, the yearly loss to evapotranspiration and infiltration was estimated to be 7.2 feet per year, or 0.6 feet per month. During summer, we'll assume a loss of 1 foot per month, Therefore, without any rain or water application, the number of months the playa would contain water through the summer would be roughly equivalent to the number of feet (in depth) the playa contained. Near the bottom of the depression, a playa with a surface area of 2 acres containing about 3 acre-feet of water would lose about 2 acre-feet in a month. At a generation rate of 0.44 acre-feet per day, the plant would need to apply about 4.5 day's worth of non-contact water per month to maintain the playa at this level.

4.0 CONCLUSIONS

The actual amount of non-contact wastewater available from the plant and the actual storage capacities may be significantly different than those discussed in this report. However, based on the information available, the following preliminary conclusions are provided.

Besides possibly flooding part of the field in which the playa exists, there appears to be no real concern that applying non-contact wastewater to the playa will result in flooding beyond the field in which it lies, under typical conditions. However, if existing conditions do not resemble the topographic map which indicates five feet of elevation relief between the railroad culverts and the 12-acre playa bottom, there may be less storage capacity in the quarter section than indicated in this report.

Application of non-contact wastewater to the playa would be an ongoing management task. Under normal conditions, it appears that in addition to maintaining the playa, the non-contact wastewater could also be used for other beneficial uses. In other words, restoration of the playa would not likely require all of the non-contact wastewater generated by the plant.

Restoration of the playa appears feasible with regard to hydrology. The preliminary feasibility analysis indicates the following:

- Approximately 6 acres of wetland and moist soil habitat could be restored that would include on average approximately 1 acre of semi-permanent shallow open water, 2 acres of emergent herbaceous wetlands, and approximately 3 acres of moist grassland/forbland or prairie.
- During the summer, approximately one week's supply of non-contact wastewater would need to be applied to the center (approximately 9 – 24 acres) portions of the playa per month using the center pivot to enhance or restore approximately 6 acres of playa wetland and moist soil habitat.
- During winter, about 1.5 month's equivalent of non-contact wastewater could be stored within approximately the bottom 12-acres of the playa.
- Even with significant rainfall and constant application of all the non-contact wastewater to the entire center pivot area (126 acres), it would not be likely to cause any flooding beyond the northwest quarter of Section 17.

NRCS Runoff Method

Site Data

Location:	Hugoton, Kansas			
Acreage:	154 acres			Source:
Design Storms:	1-year, 1-hour	1.2 inches.	30.48 mm	2
	2-year, 1-hour	1.4 inches.	35.56 mm	2
	5-year, 1-hour	2.2 inches.	55.88 mm	2
	10-year, 1-hour	2.3 inches.	58.42 mm	2
	25-year, 1-hour	2.9 inches.	73.66 mm	2
	50-year, 1-hour	3.1 inches.	78.74 mm	2
	100-year, 1-hour	3.5 inches.	88.9 mm	2
	1-day record	4.52 inches.	114.808 mm	3
	1-year, 24-hour	2.0 inches.	50.8 mm	2
	2-year, 24-hour	2.5 inches.	63.5 mm	2
	5-year, 24-hour	3.3 inches.	83.82 mm	2
	10-year, 24-hour	4.0 inches.	101.6 mm	2
	25-year, 24-hour	4.7 inches.	119.38 mm	2
	50-year, 24-hour	5.4 inches.	137.16 mm	2
	100-year, 24-hour	5.8 inches.	147.32 mm	1

NRCS Runoff Method	1
Hydrologic Soil Group B	3

Percent	Acreage	Land Use	Treatment	Hydrologic Condition	CN[1]	NA
0	0	row crops	straight row	poor	81	0
100	154	small grain	straight row	good	75	11550
0	0	pasture			0	0
0	0	roads			0	0
100	154					11550

	Antecedent Rainfall Conditions		
	II (avg.)	I (dry)	III (wet)
weighted curve number	75	59.25	85.50
S = (25,400/CN) - 254 =	84.67	174.69	43.08

$$Q = \frac{(I - 0.2*S)^2}{I + 0.8*S}$$

Condition II

Q (mm)	Q (in)		Volume ac-in	Volume ac-ft
1.87	0.07	1-year, 1-hour	11.33	0.94
3.36	0.13	2-year, 1-hour	20.37	1.70
12.27	0.48	5-year, 1-hour	74.40	6.20
13.64	0.54	10-year, 1-hour	82.72	6.89
22.76	0.90	25-year, 1-hour	137.99	11.50
26.08	1.03	50-year, 1-hour	158.12	13.18
33.07	1.30	100-year, 1-hour	200.48	16.71
52.48	2.07	1-day record	318.18	26.51
9.68	0.38	1-year, 24-hour	58.67	4.89
16.52	0.65	2-year, 24-hour	100.18	8.35
29.52	1.16	5-year, 24-hour	178.98	14.91
42.33	1.67	10-year, 24-hour	256.67	21.39
56.09	2.21	25-year, 24-hour	340.08	28.34
70.55	2.78	50-year, 24-hour	427.72	35.64
79.05	3.11	100-year, 24-hour	479.30	39.94

Condition I

Q (mm)	Q (in)		ac-in	ac-ft
0.12	0.00	1-year, 1-hour	0.71	0.06
0.00	0.00	2-year, 1-hour	0.01	0.00
2.24	0.09	5-year, 1-hour	13.59	1.13
2.78	0.11	10-year, 1-hour	16.87	1.41
7.03	0.28	25-year, 1-hour	42.60	3.55
8.78	0.35	50-year, 1-hour	53.24	4.44
12.73	0.50	100-year, 1-hour	77.21	6.43
25.06	0.99	1-day record	151.93	12.66
1.32	0.05	1-year, 24-hour	8.01	0.67
4.01	0.16	2-year, 24-hour	24.33	2.03
10.69	0.42	5-year, 24-hour	64.80	5.40
18.41	0.72	10-year, 24-hour	111.63	9.30
27.52	1.08	25-year, 24-hour	166.83	13.90
37.73	1.49	50-year, 24-hour	228.79	19.07
43.99	1.73	100-year, 24-hour	266.74	22.23

Condition III

Q (mm)	Q (in)		ac-in	ac-ft
7.36	0.29	1-year, 1-hour	44.63	3.72
10.37	0.41	2-year, 1-hour	62.87	5.24
24.73	0.97	5-year, 1-hour	149.93	12.49
26.71	1.05	10-year, 1-hour	161.92	13.49
39.13	1.54	25-year, 1-hour	237.25	19.77
43.44	1.71	50-year, 1-hour	263.38	21.95
52.25	2.06	100-year, 1-hour	316.79	26.40
75.55	2.97	1-day record	458.04	38.17
20.87	0.82	1-year, 24-hour	126.55	10.55
30.75	1.21	2-year, 24-hour	186.44	15.54
47.82	1.88	5-year, 24-hour	289.91	24.16
63.55	2.50	10-year, 24-hour	385.28	32.11
79.75	3.14	25-year, 24-hour	483.52	40.29
96.28	3.79	50-year, 24-hour	583.75	48.65
105.84	4.17	100-year, 24-hour	641.69	53.47

Sources and Key

[1]Soil and Water Conservation Engineering, Fourth Edition
[2]NOAA's NWS Technical Paper No. 40
[3]USDA Soil Survey of Stevens County, KS
[4] NRCS TR-55
Input Data
Output Data

NRCS Runoff Method

Site Data

Location:	Hugoton, Kansas			
Acreage:	275 acres			Source:
Design Storms:	1-year, 1-hour	1.2 inches.	30.48 mm	2
	2-year, 1-hour	1.4 inches.	35.56 mm	2
	5-year, 1-hour	2.2 inches.	55.88 mm	2
	10-year, 1-hour	2.3 inches.	58.42 mm	2
	25-year, 1-hour	2.9 inches.	73.66 mm	2
	50-year, 1-hour	3.1 inches.	78.74 mm	2
	100-year, 1-hour	3.5 inches.	88.9 mm	2
	1-day record	4.52 inches.	114.808 mm	3
	1-year, 24-hour	2.0 inches.	50.8 mm	2
	2-year, 24-hour	2.5 inches.	63.5 mm	2
	5-year, 24-hour	3.3 inches.	83.82 mm	2
	10-year, 24-hour	4.0 inches.	101.6 mm	2
	25-year, 24-hour	4.7 inches.	119.38 mm	2
	50-year, 24-hour	5.4 inches.	137.16 mm	2
	100-year, 24-hour	5.8 inches.	147.32 mm	1

NRCS Runoff Method		1
Hydrologic Soil Group	B	3

Percent	Acreage	Land Use	Treatment	Hydrologic Condition	CN[1]	NA
0	0	row crops	straight row	poor	81	0
100	275	small grain	straight row	good	75	20625
0	0	pasture			0	0
0	0	roads			0	0
100	275					20625

	Antecedent Rainfall Conditions		
	II (avg.)	I (dry)	III (wet)
weighted curve number	75	59.25	85.50
S = (25,400/CN) - 254 =	84.67	174.69	43.08

$$Q = \frac{(I - 0.2*S)^2}{I + 0.8*S}$$

Condition II

Q (mm)	Q (in)		Volume ac-in	Volume ac-ft
1.87	0.07	1-year, 1-hour	20.23	1.69
3.36	0.13	2-year, 1-hour	36.37	3.03
12.27	0.48	5-year, 1-hour	132.85	11.07
13.64	0.54	10-year, 1-hour	147.71	12.31
22.76	0.90	25-year, 1-hour	246.40	20.53
26.08	1.03	50-year, 1-hour	282.37	23.53
33.07	1.30	100-year, 1-hour	358.00	29.83
52.48	2.07	1-day record	568.17	47.35
9.68	0.38	1-year, 24-hour	104.76	8.73
16.52	0.65	2-year, 24-hour	178.90	14.91
29.52	1.16	5-year, 24-hour	319.60	26.63
42.33	1.67	10-year, 24-hour	458.33	38.19
56.09	2.21	25-year, 24-hour	607.28	50.61
70.55	2.78	50-year, 24-hour	763.79	63.65
79.05	3.11	100-year, 24-hour	855.89	71.32

Condition I

Q (mm)	Q (in)		ac-in	ac-ft
0.12	0.00	1-year, 1-hour	1.26	0.11
0.00	0.00	2-year, 1-hour	0.02	0.00
2.24	0.09	5-year, 1-hour	24.27	2.02
2.78	0.11	10-year, 1-hour	30.12	2.51
7.03	0.28	25-year, 1-hour	76.06	6.34
8.78	0.35	50-year, 1-hour	95.07	7.92
12.73	0.50	100-year, 1-hour	137.88	11.49
25.06	0.99	1-day record	271.31	22.61
1.32	0.05	1-year, 24-hour	14.29	1.19
4.01	0.16	2-year, 24-hour	43.45	3.62
10.69	0.42	5-year, 24-hour	115.71	9.64
18.41	0.72	10-year, 24-hour	199.34	16.61
27.52	1.08	25-year, 24-hour	297.91	24.83
37.73	1.49	50-year, 24-hour	408.55	34.05
43.99	1.73	100-year, 24-hour	476.32	39.69

Condition III

Q (mm)	Q (in)		ac-in	ac-ft
7.36	0.29	1-year, 1-hour	79.70	6.64
10.37	0.41	2-year, 1-hour	112.26	9.35
24.73	0.97	5-year, 1-hour	267.73	22.31
26.71	1.05	10-year, 1-hour	289.14	24.10
39.13	1.54	25-year, 1-hour	423.66	35.30
43.44	1.71	50-year, 1-hour	470.32	39.19
52.25	2.06	100-year, 1-hour	565.70	47.14
75.55	2.97	1-day record	817.94	68.16
20.87	0.82	1-year, 24-hour	225.98	18.83
30.75	1.21	2-year, 24-hour	332.93	27.74
47.82	1.88	5-year, 24-hour	517.70	43.14
63.55	2.50	10-year, 24-hour	688.00	57.33
79.75	3.14	25-year, 24-hour	863.44	71.95
96.28	3.79	50-year, 24-hour	1042.41	86.87
105.84	4.17	100-year, 24-hour	1145.87	95.49

Sources and Key
[1]Soil and Water Conservation Engineering, Fourth Edition
[2]NOAA's NWS Technical Paper No. 40
[3]USDA Soil Survey of Stevens County, KS
[4] NRCS TR-55
Input Data
Output Data