Cottonwood Ranch Broad-Scale Recharge Update

Water Advisory Committee Meeting
Conference Call
February 6, 2018

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

Timeline

- Documents for approval at GC meeting:
  - Final design plans and bid documents
  - Water service agreement w/ CNPPID
  - Land agreement w/ NPPD
  - Operations criteria/model
- Permitting:
  - PCN (404) submitted to Corps
  - Aquifer storage & recovery w/ DNR
  - Dam safety exemption w/ DNR

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RECOVERY IMPLEMENTATION PROGRAM

Timeline (continued)

- Construction:
  - Permits are critical components
  - Summer 2018
    - Berms and recharge infrastructure
      - Earthwork
      - Water control structure
      - Distribution pipeline
      - Etc.
  - Post-irrigation 2018
    - Pipeline from Phelps Co. Canal
- Functioning project in late 2018 or early 2019

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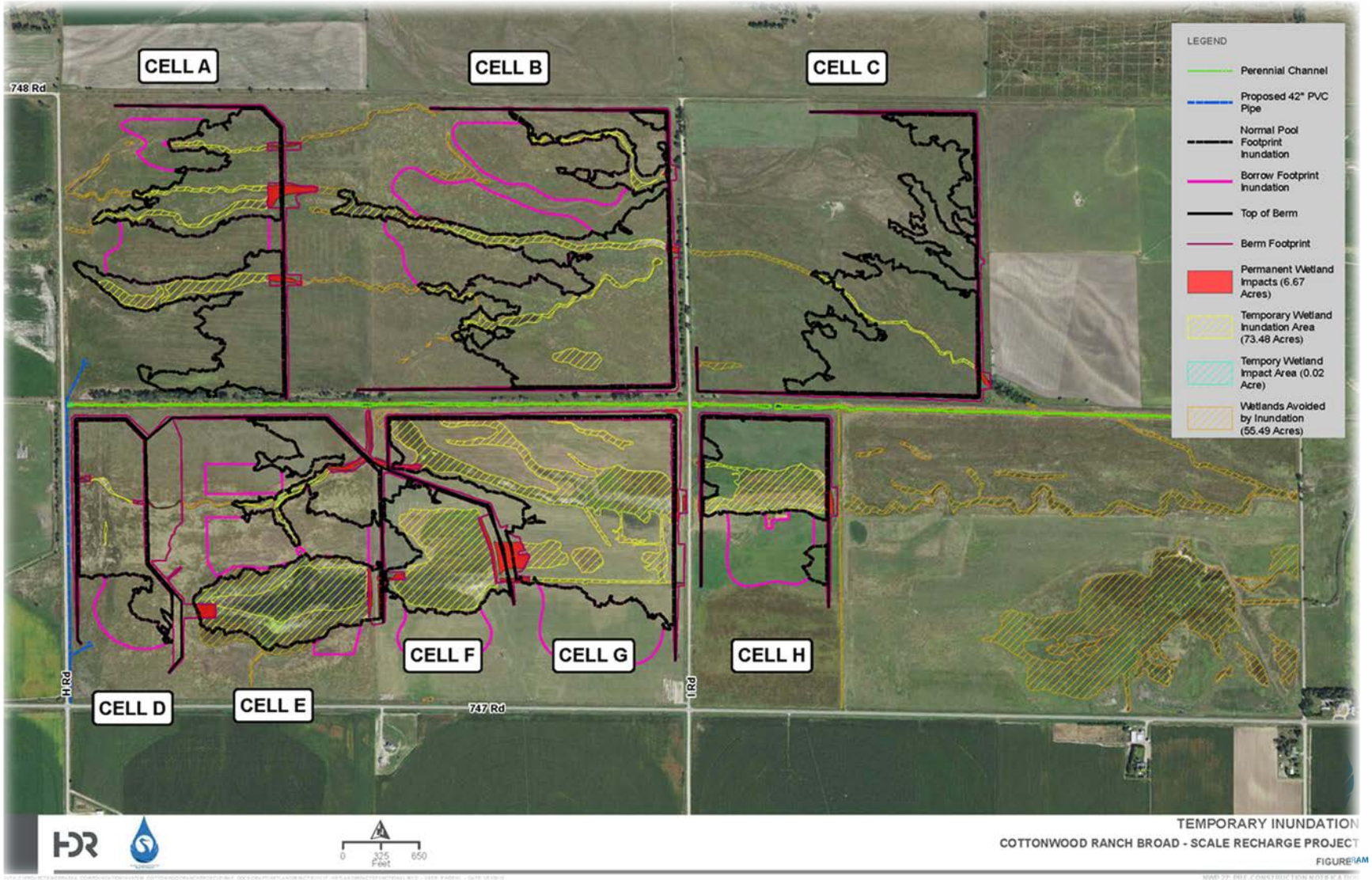
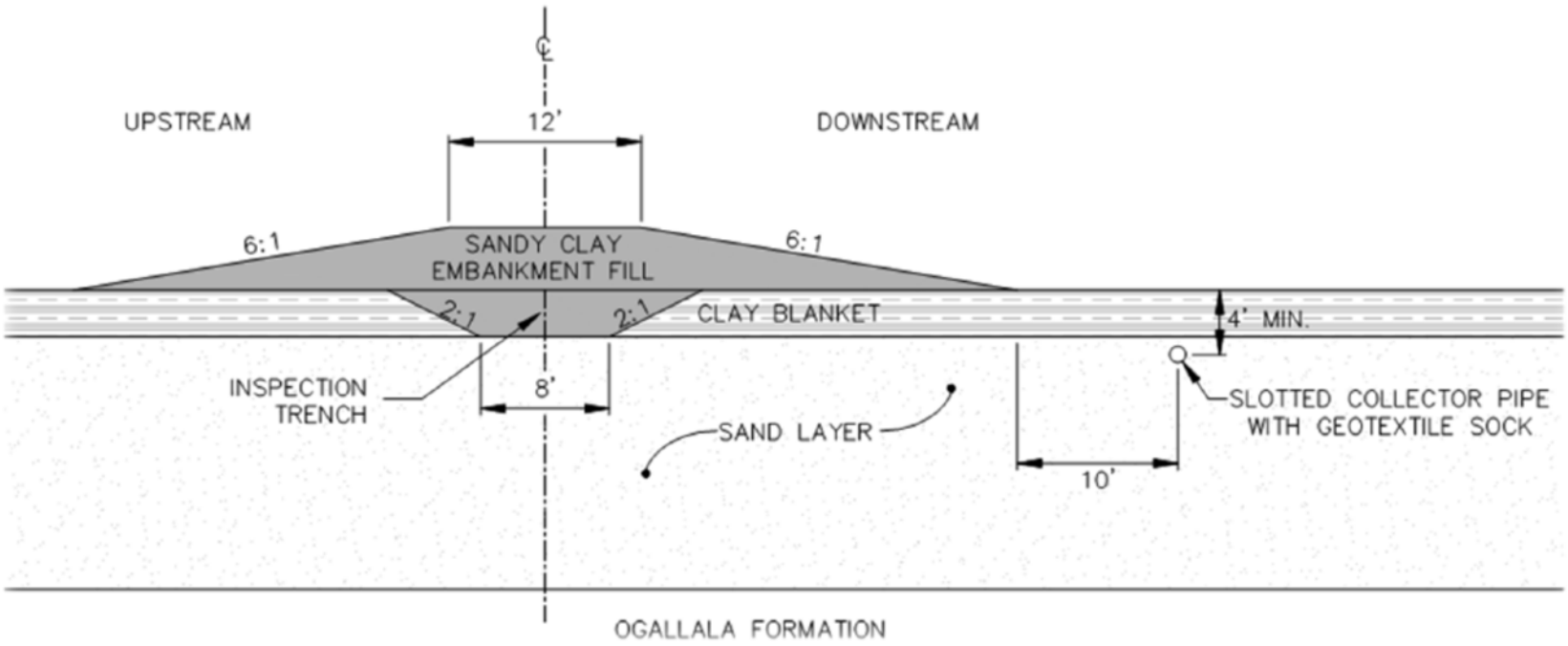
General Layout



Berm Section Typical



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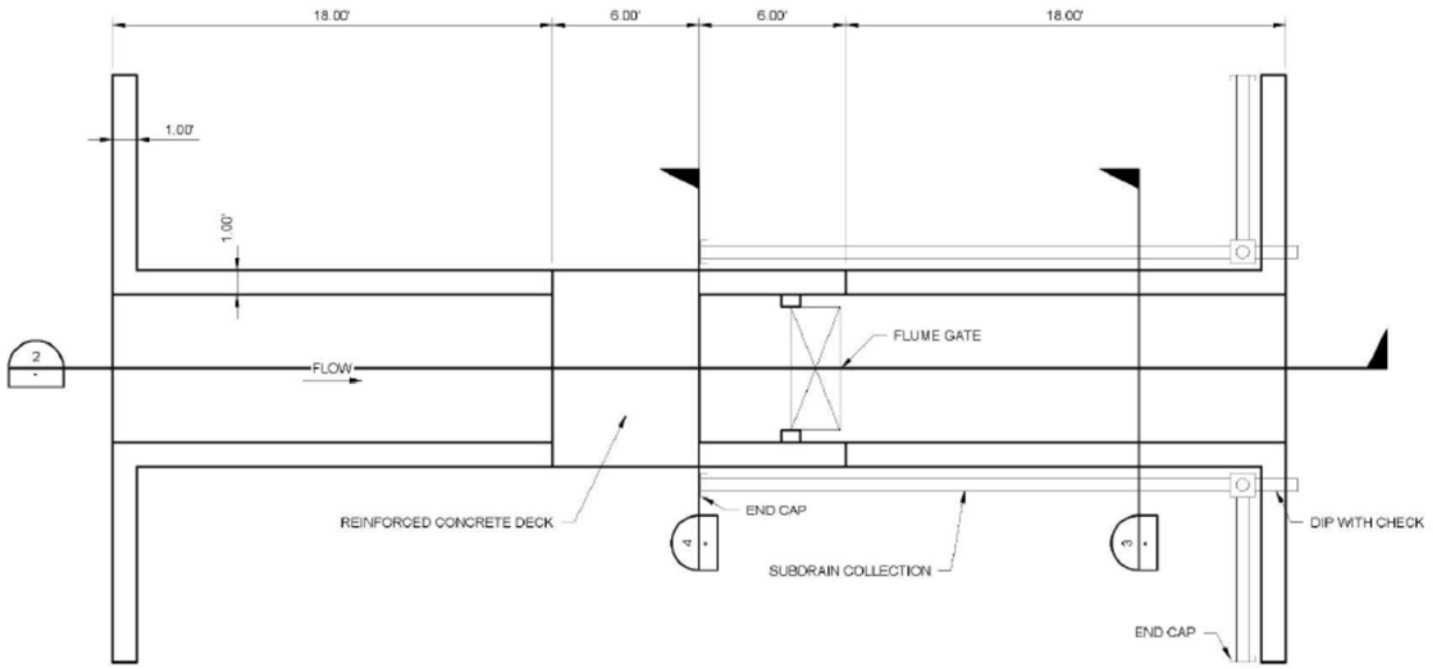
Flume (Plan) Typical



FLUME STRUCTURE
PLAN VIEW

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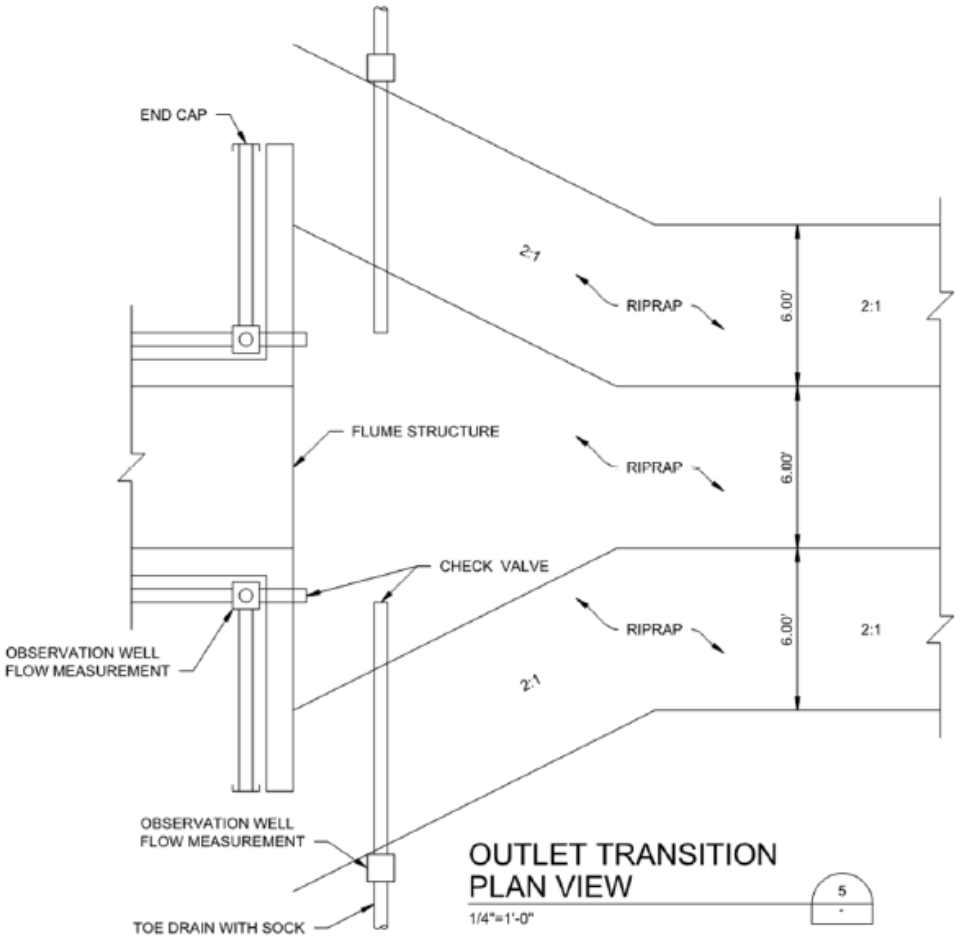
Outlet (Plan) Typical



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Preliminary Design

Will reduce some amount as a result of final surface design

	Berm	With Borrow Areas
Physical Attributes		
Recharge area, acres	353	470
Recharge acres, less than or equal to 12 inches	150	267
Recharge acres, greater than 12 inches	203	203
Recharge volume, acre-feet	458	575
Earthwork volume, cubic yards	109,000	

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Preliminary Operations

- Based on numbers on previous slide (will likely change a bit but shows ballpark and variance)
- Year-round operations (1995 – 2016 flows)
- Avg. preliminary yield of 5,000 AF

	Diverted Vol [AF/yr]	Days of Diversions [#/yr]	Recharged Vol [AF/yr]	Yield Vol [AF/yr]
Avg.	20,000	140	13,000	5,900
Min.	1,900	~ 10	1,800	130
Max	48,000	> 300	28,000	17,000

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Questions

PLATTE RIVER
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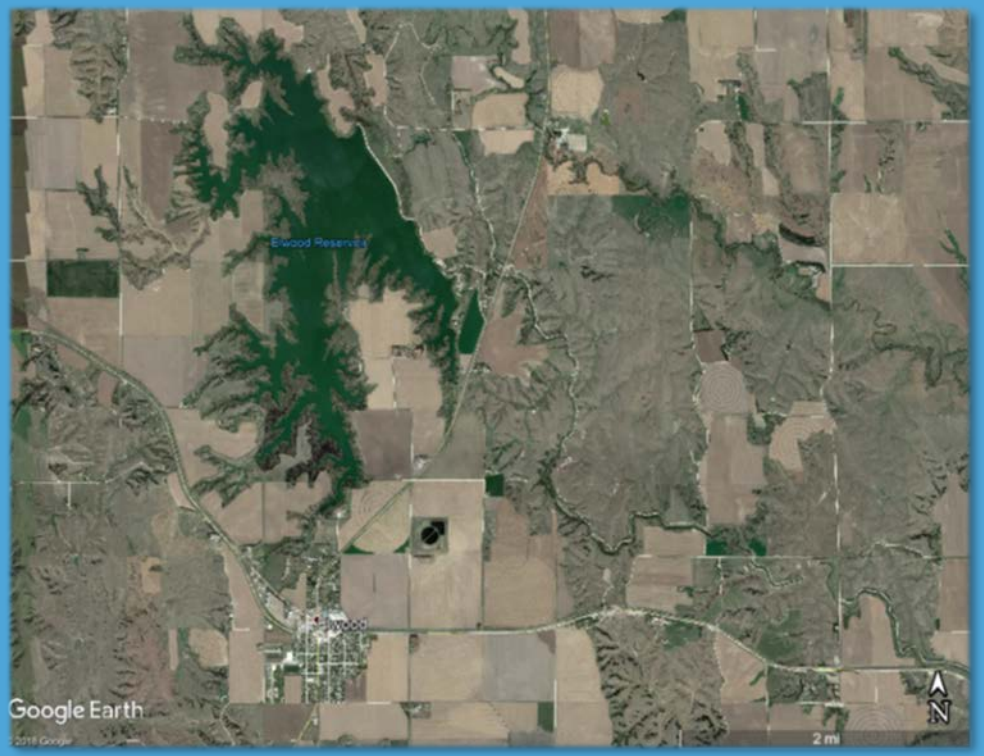

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Elwood Reservoir Recharge Pre-Scoring Analysis

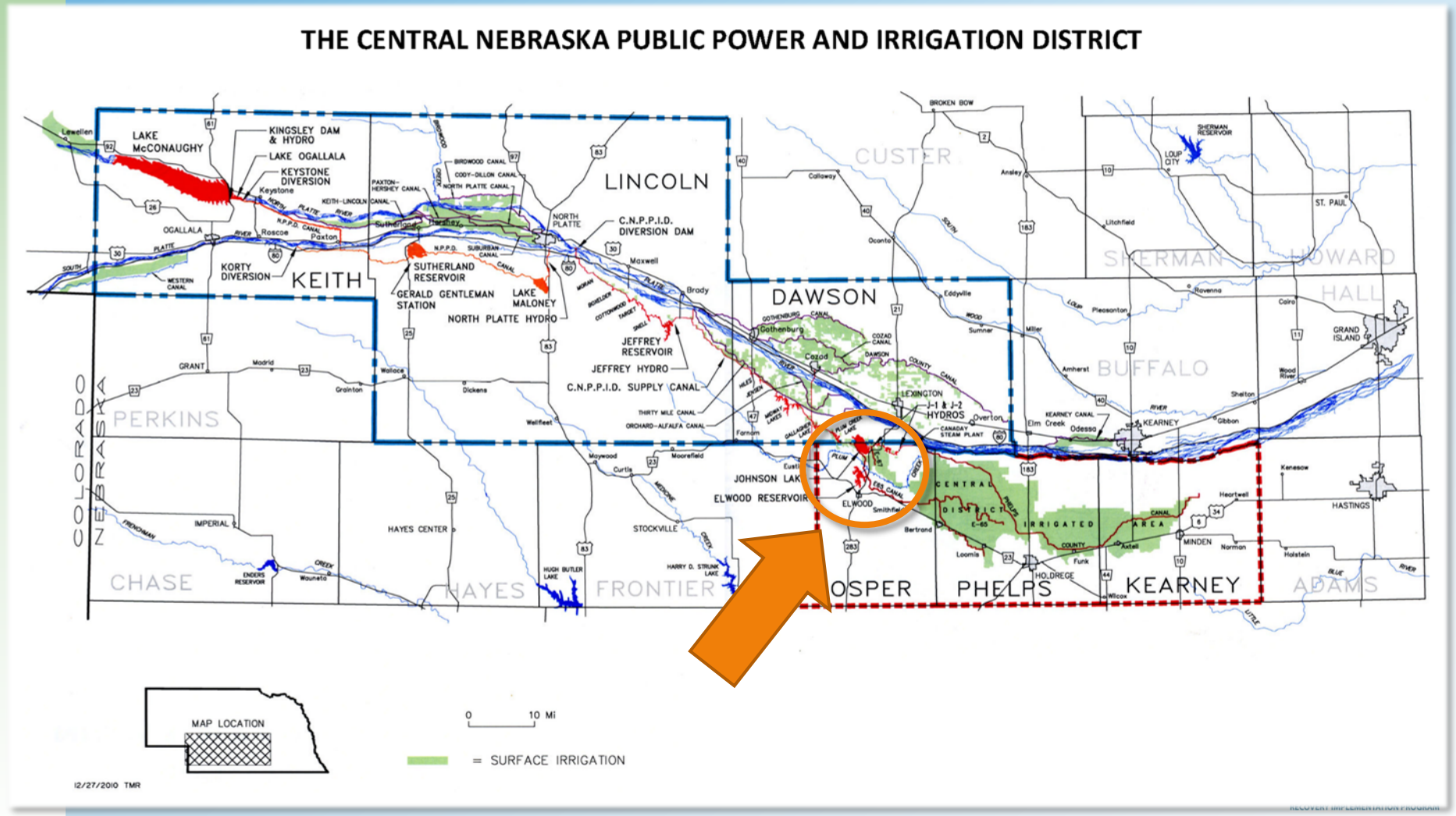
Water Advisory Committee
February 6th, 2018

Bill Hahn, P.G.
Special Advisor – Groundwater

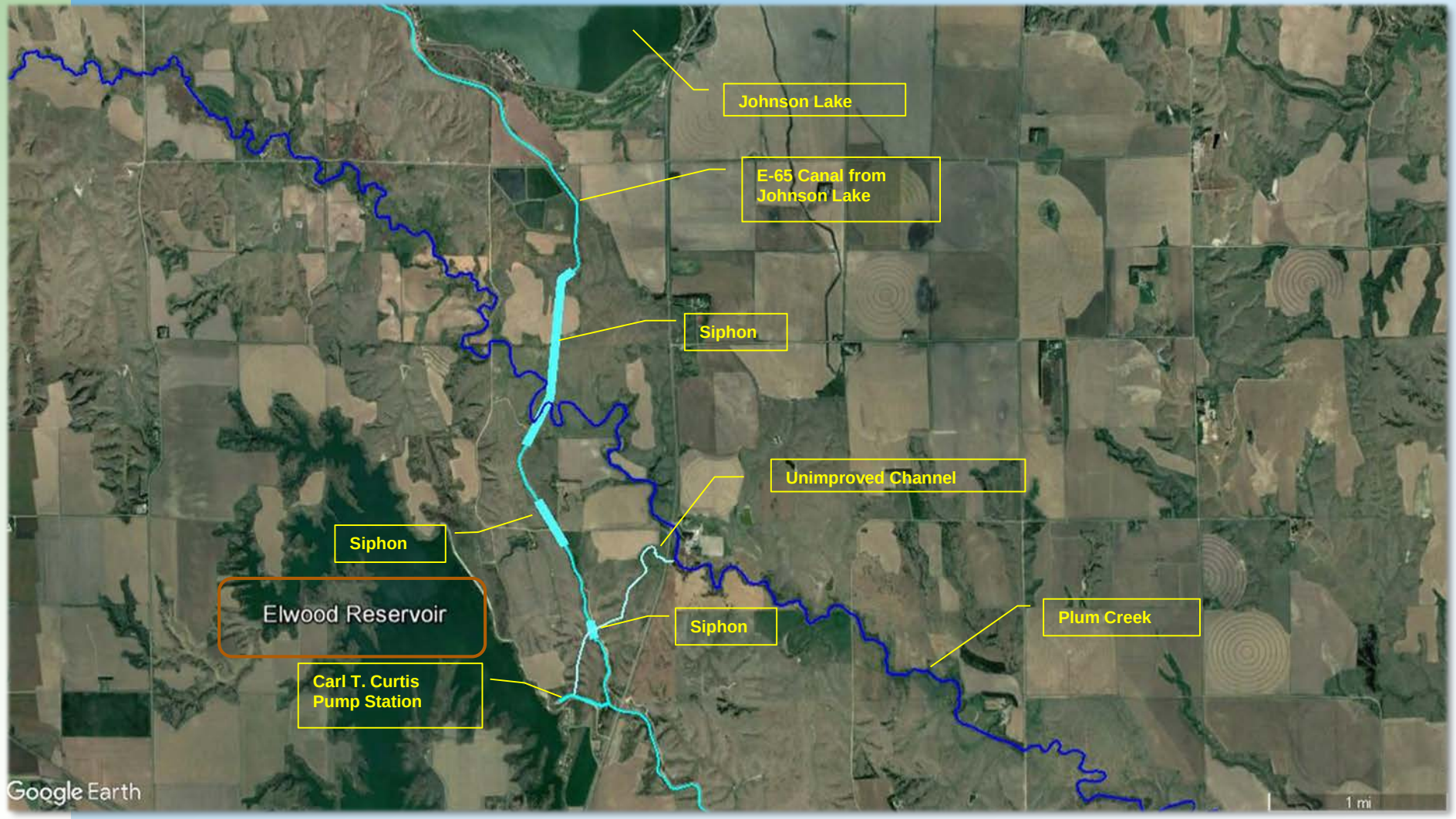
HAHN WATER RESOURCES, LLC

Scott Griebling
EDO Staff

Background


THE CENTRAL NEBRASKA PUBLIC POWER AND IRRIGATION DISTRICT
LAKE McCONAUGHY
KINGSLEY DAM & HYDRO
LAKE OGALLALA
KEYSTONE DIVERSION
KORTY DIVERSION
KEITH
LINCOLN
SUTHERLAND RESERVOIR
GERALD GENTLEMAN STATION
LAKE MALONEY
NORTH PLATTE HYDRO
C.N.P.P.I.D. DIVERSION DAM
JEFFREY RESERVOIR
JEFFREY HYDRO
C.N.P.P.I.D. SUPPLY CANAL
DAWSON
CUSTER
SHERMAN
HOWARD
HALL
BUFFALO
PERKINS
CHASE
HAYES
FRONTIER
GOSPER
PHELPS
KEARNEY
ADAMS
JOHNSON LAKE
ELWOOD RESERVOIR
J-1 & J-2 HYDROS
CENTRAL NEBRASKA PUBLIC POWER AND IRRIGATION DISTRICT
MAP LOCATION
0 10 Mi
= SURFACE IRRIGATION
12/27/2010 TMR

Background


Johnson Lake
E-65 Canal from Johnson Lake
Siphon
Unimproved Channel
Siphon
Elwood Reservoir
Siphon
Plum Creek
Carl T. Curtis Pump Station
Google Earth
1 mi

Recharge in Elwood

- Elwood is unlined & seeps 30 to 100+ af/day
- Elwood has been used by PRRIP and others for intentional recharge
- Past assumption—50% of recharge flows to the Platte, 50% flows to the Republican
- PRRIP is working to score the Elwood recharge project

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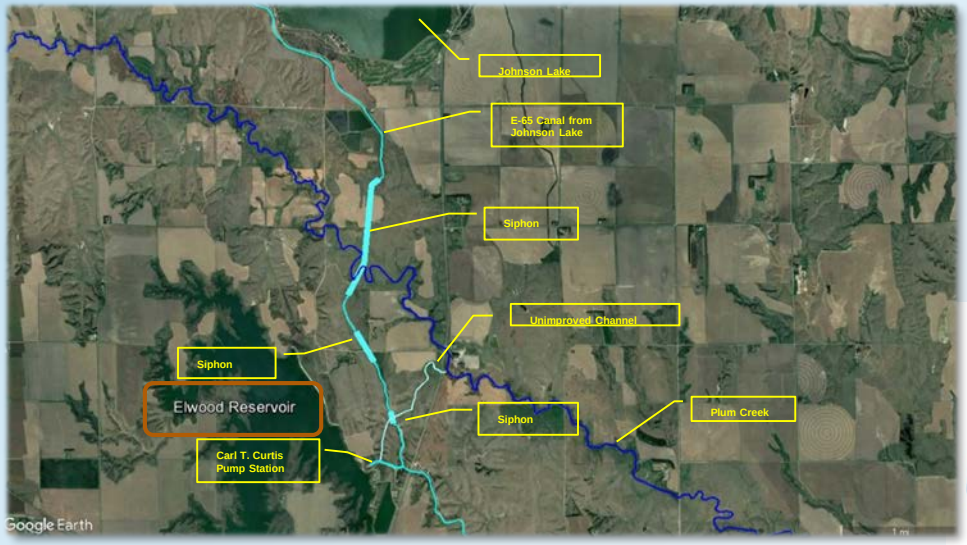
RECOVERY IMPLEMENTATION PROGRAM

Scoring Questions

- Where does the water go?
  - Platte River or Republican River?
- Timing and location of returns
  - Plum Creek?
  - Platte River?



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Scoring Options

Analytical Approach

COHYST Model

Standalone GW Model

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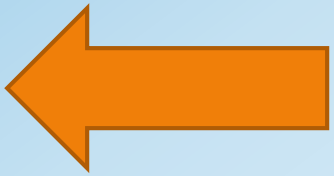
Scoring Elwood

Analytical Approach

COHYST Model  (local recalibration)

Standalone GW Model

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Elwood Reservoir Seepage and Return Flow Analysis

Water Advisory Committee Briefing

February 6, 2018

Bill Hahn, P.G.
Special Advisor - Groundwater

Hahn Water Resources, LLC

PRRIP Recharge Background

- Program Begins Taking Delivery of Water To Elwood Reservoir May 2015 (about 22,800 AF through August 2017)
- Portion of Water Leaks from Reservoir and Recharges the Groundwater System
- Water Entering Groundwater System "Returns" to River via Several Pathways
- Program Interest - Returns Occurring at Times of Shortage to Target Flows
- Preliminary Work in 2015 to Quantify Timing of Returns (rough)
- Current Work Provides Better Definition of Timing and Location of Return Flows
- Results – Response Functions to Analyze Month-by-Month Timing and Location of *Return Flows* for *Scoring* Based on Month-by-Month *Supply*

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Return Flows

Return Flows = water that seeps from Elwood and "returns" to the hydrologic system

Where can the return flows go?

- Subsurface Flow to Platte River (re-emerge at river)
- Subsurface Flow to Republican River (re-emerge at river)
- Interception by Plum Creek
- Interception by Tributaries and Drains in Republican Basin
- To Groundwater Storage

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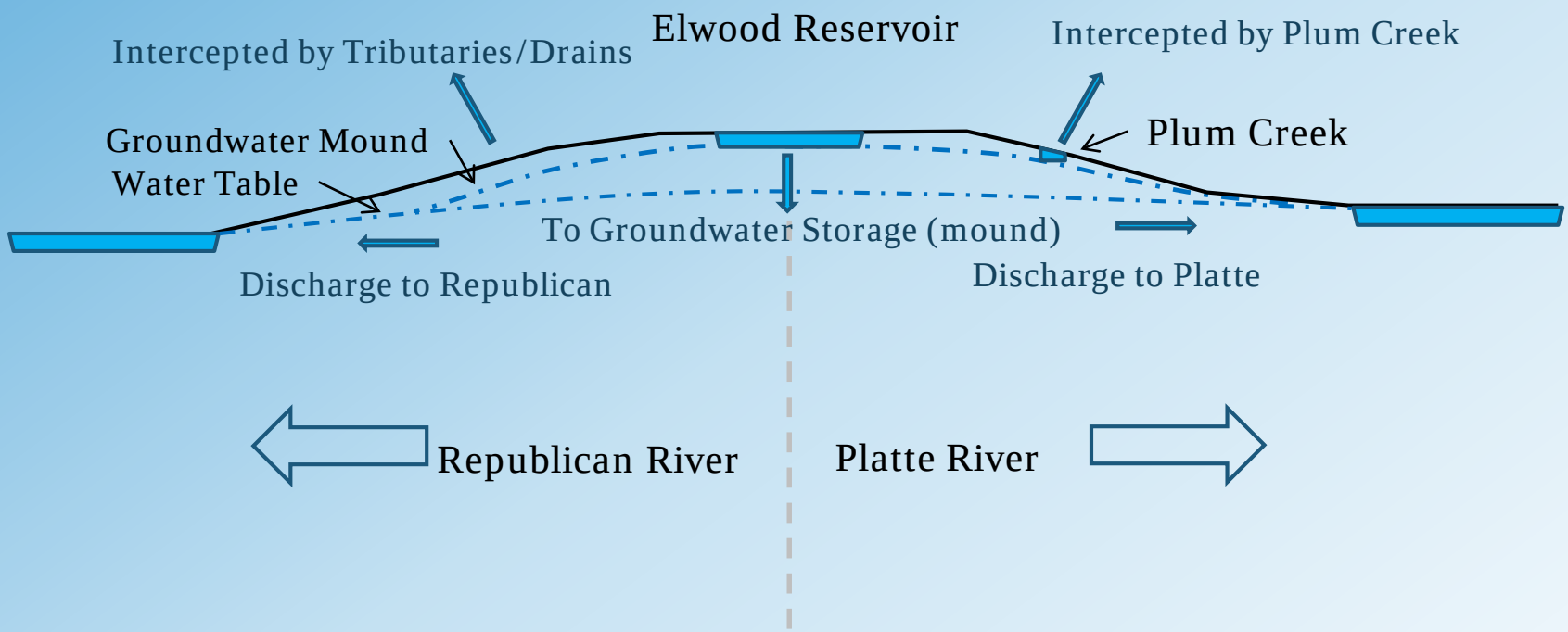
Return Flow and Seepage Analysis



Where Can Return Flows Go?

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Methodology

1. Losses from Elwood Reservoir = Gains (recharge) to Groundwater
2. Select Method for Analysis of Return Flows (Analytical solution/New model/Existing COHYST model COHYST)
3. Study Team - EDO, HWR, ERC
4. Review and Adjust Model Calibration
5. Run Model (2x)
   - Baseline (existing conditions; historic recharge)
   - Impact Run (10 cfs continuous recharge)
6. Obtain Model Predictions of Return Flows
7. Extend Record from 26 Years (COHYST) to 48 Years (Op-Study Hydro)
8. Recompile to Predict Response to Monthly Impulses

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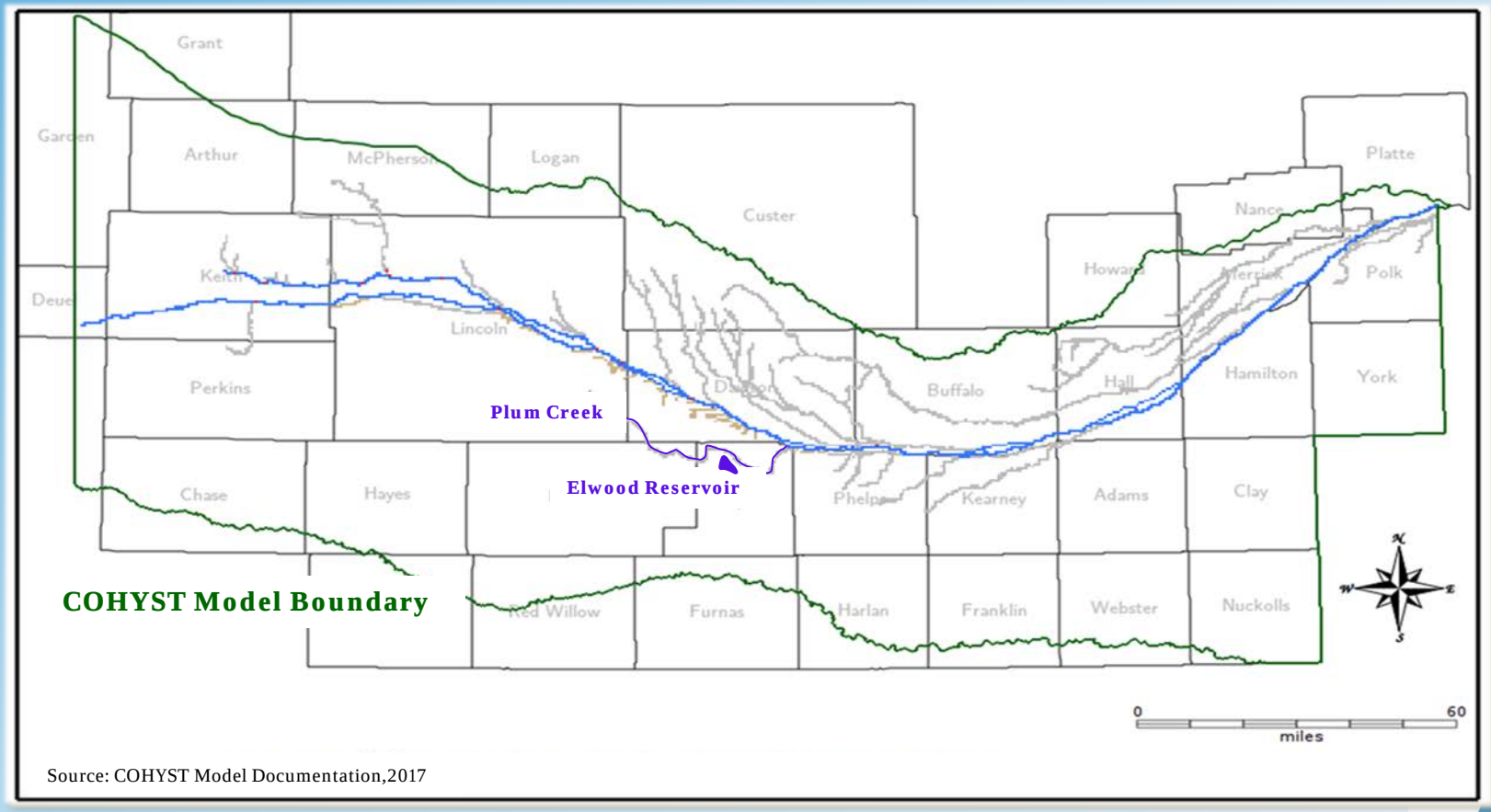
Area of Study and COHYST Model Boundaries



Source: COHYST Model Documentation,2017

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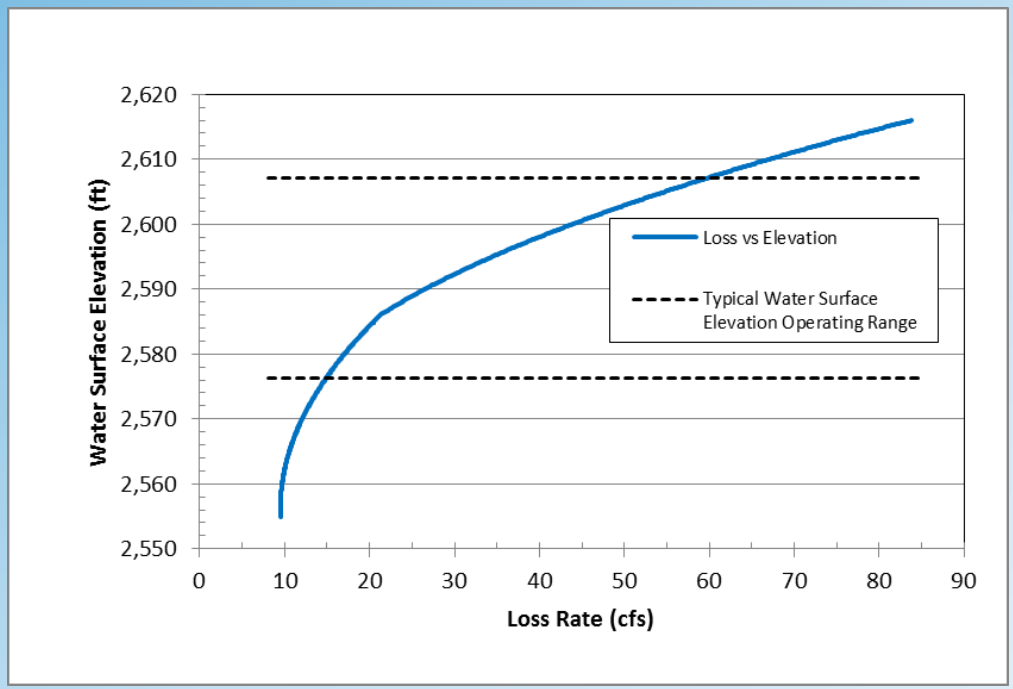

Source: CNPPID

Elwood Reservoir Loss Rate vs. Water Surface Elevation

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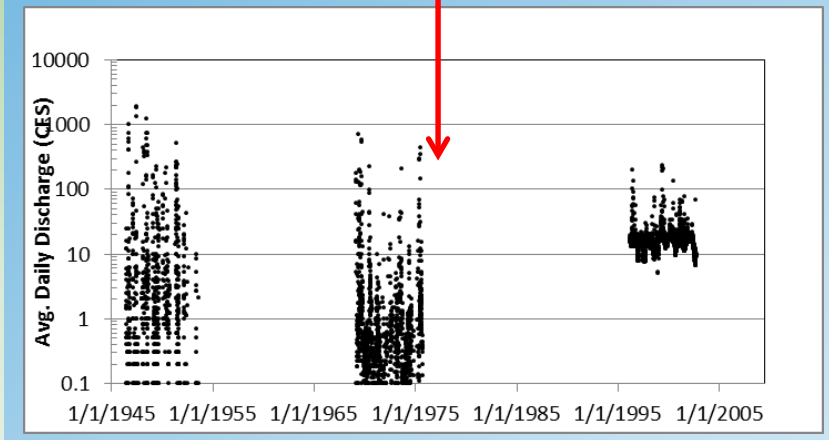
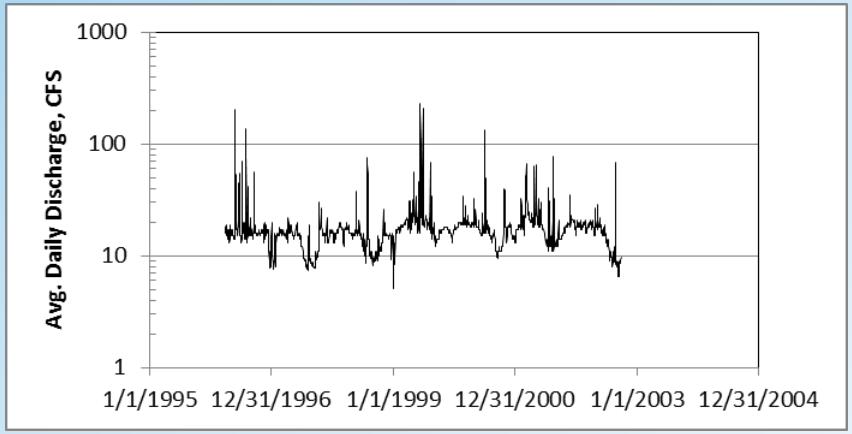
Elwood On-Line 1976





Long-term Record

Recent Record

Average Daily Discharge Plum Creek Near Smithfield

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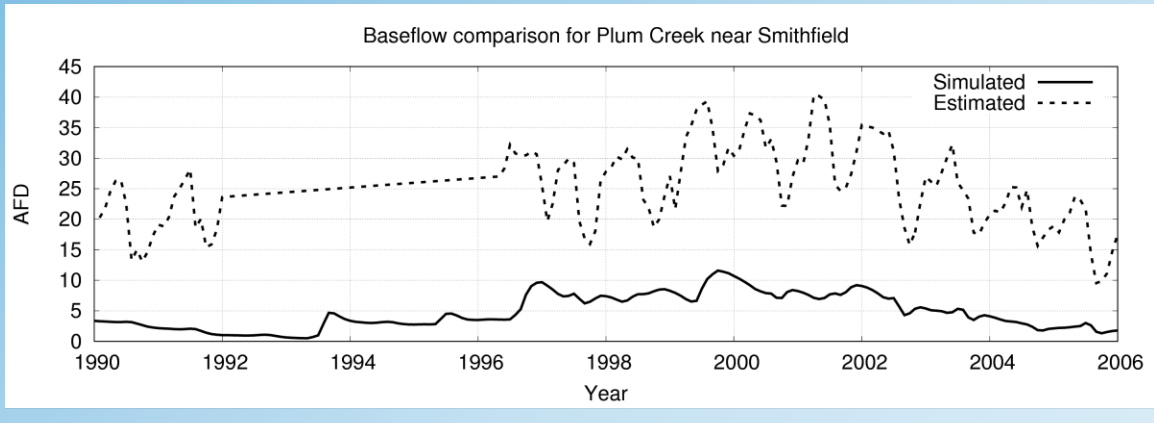

Source: Presentation by Lee Wilson and Associates 2/7/2017

Simulated gains are much lower than observed. For all previous models the simulated values were higher than observed. This may be related to other problems in the Phelps County area.

Plum Creek Calibration in the COHYST Model

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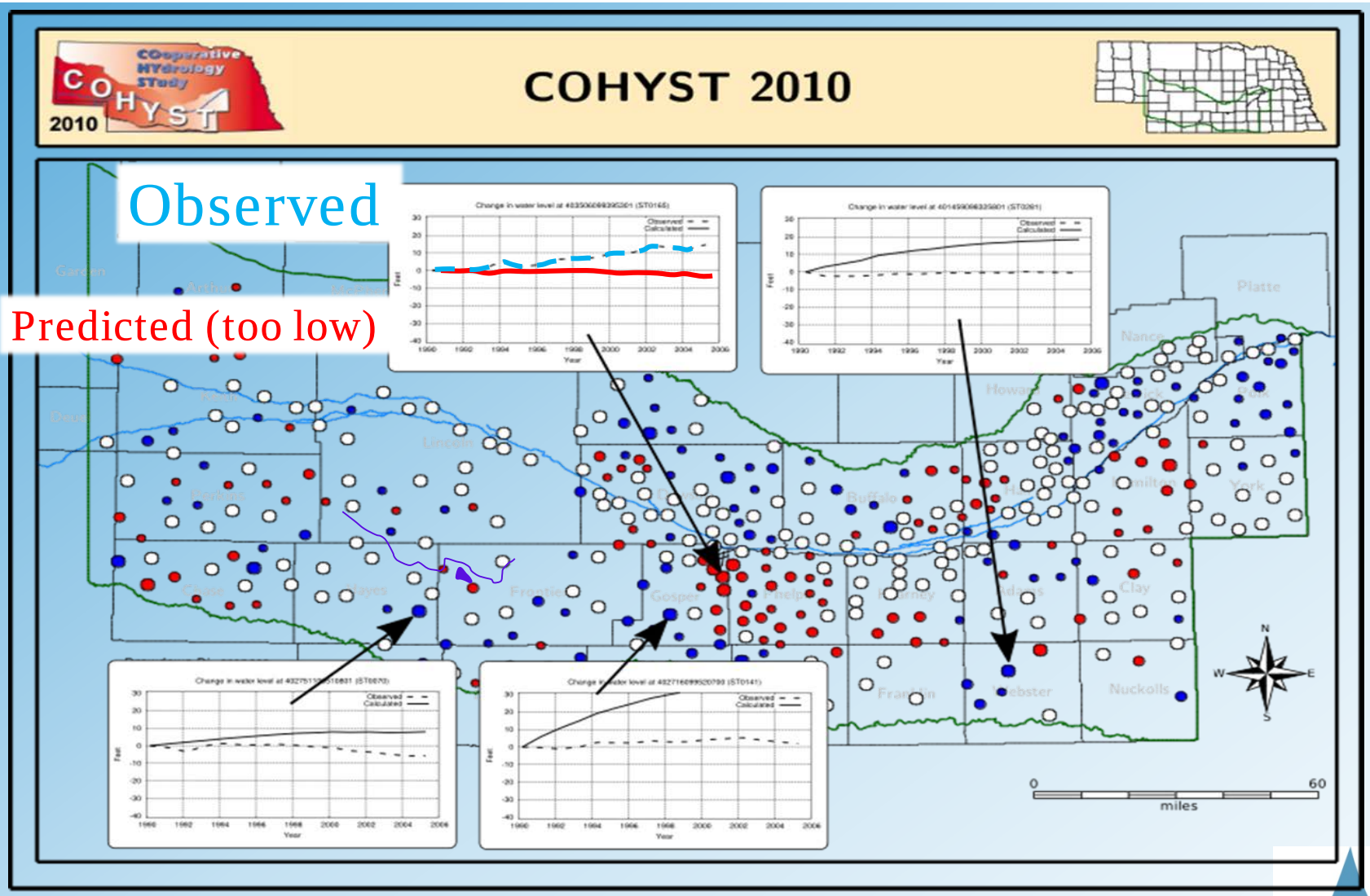

Source: COHYST Model Documentation,2017

Water Level Calibration in the COHYST Model

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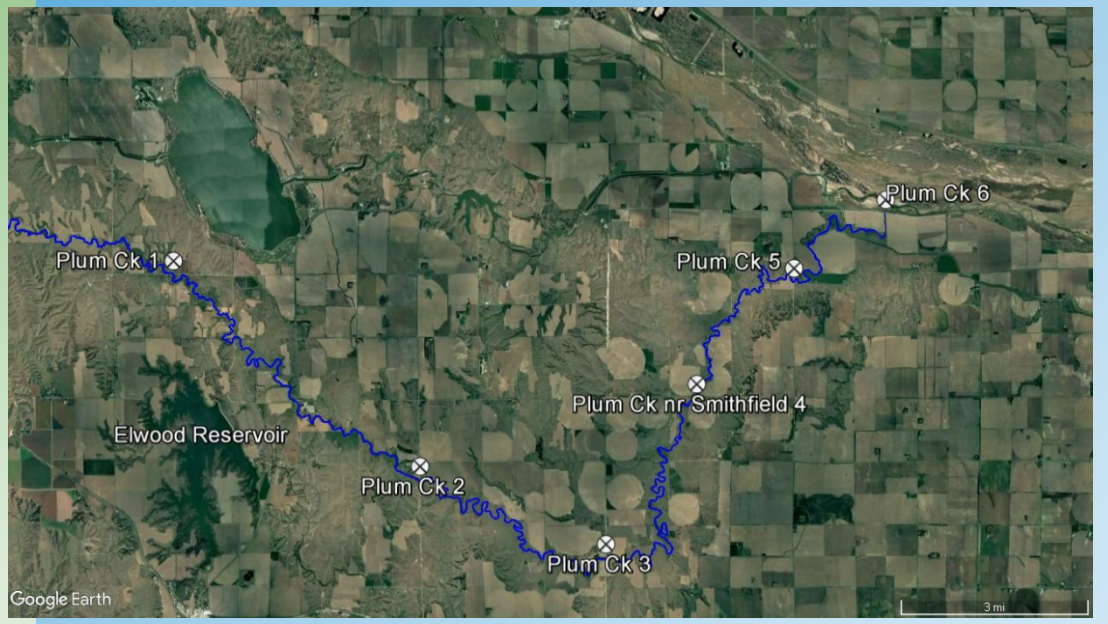
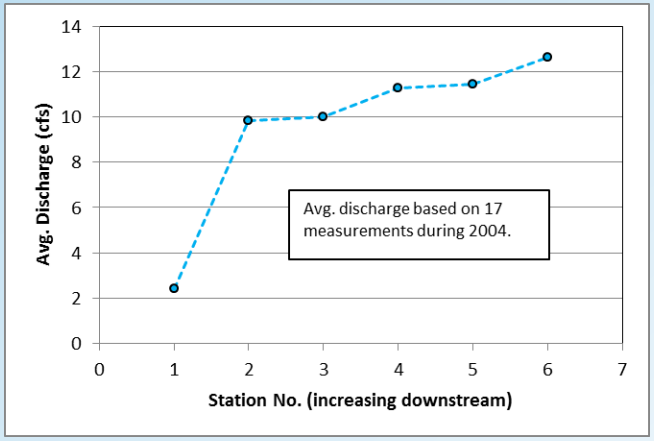


Discharge Measurement Locations



Average Measured Discharge

Locations of Discharge Measurements in Plum Creek

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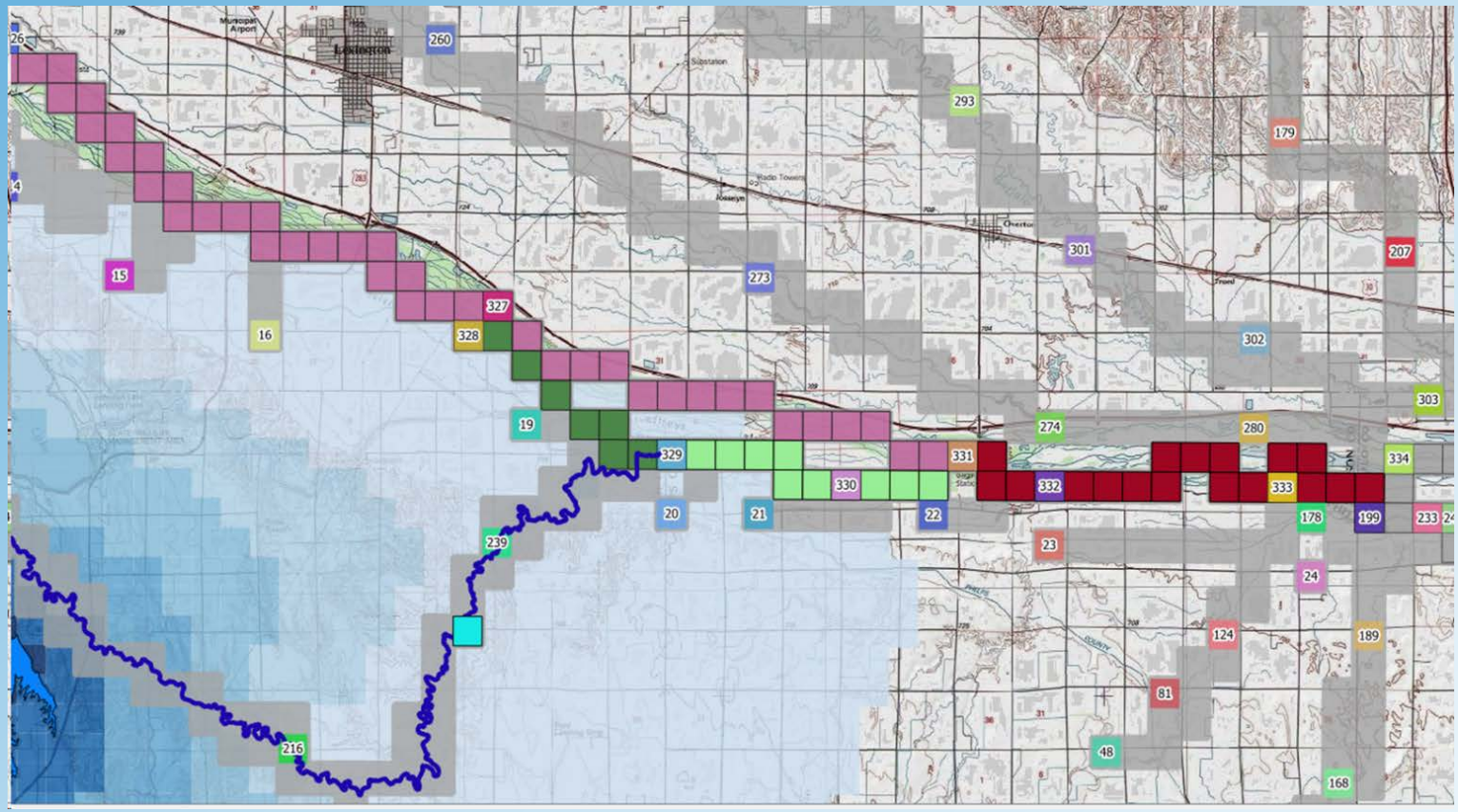

Model Representation of Stream Reaches for Plum Creek and Platte River

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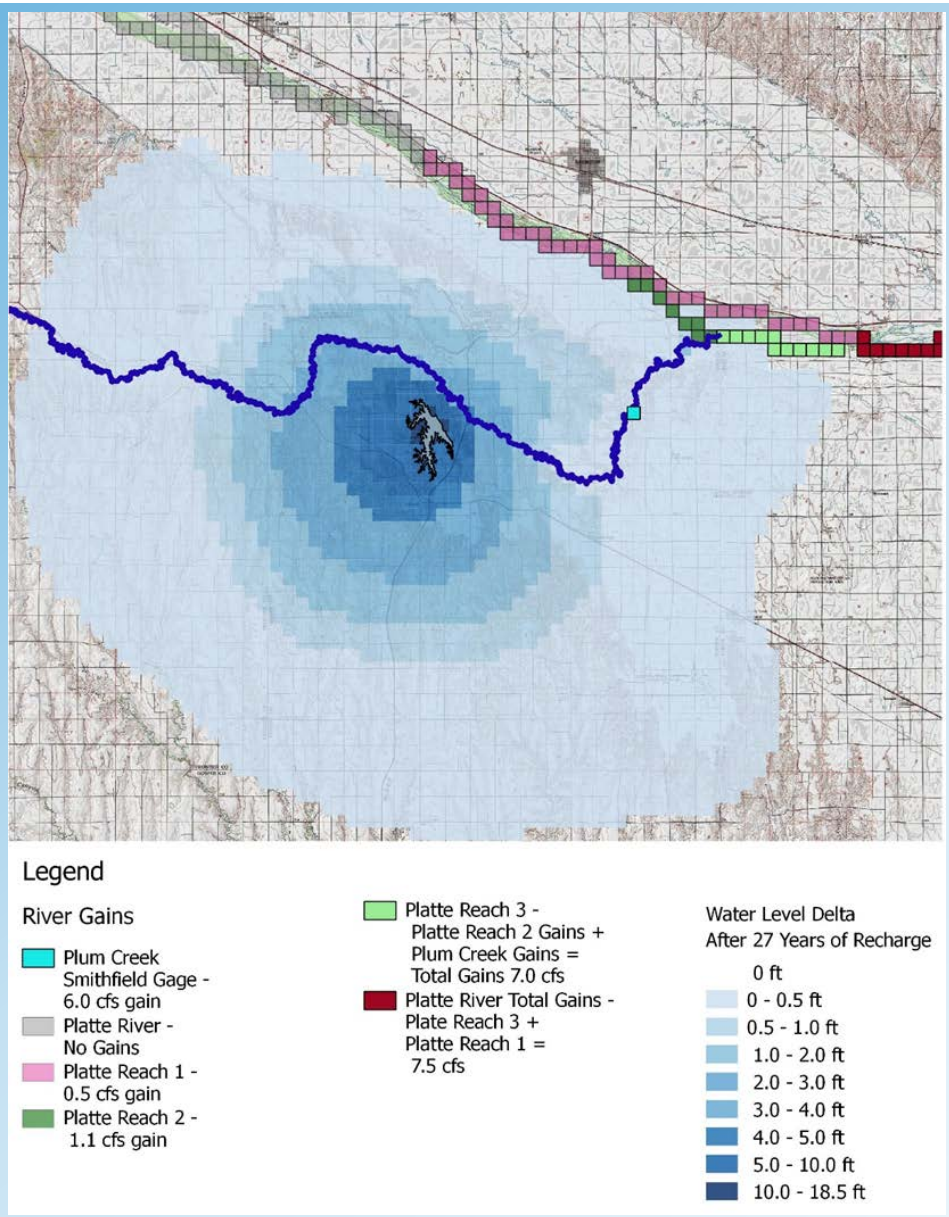

Predicted Water Level Rise Following 26 Years of Recharge

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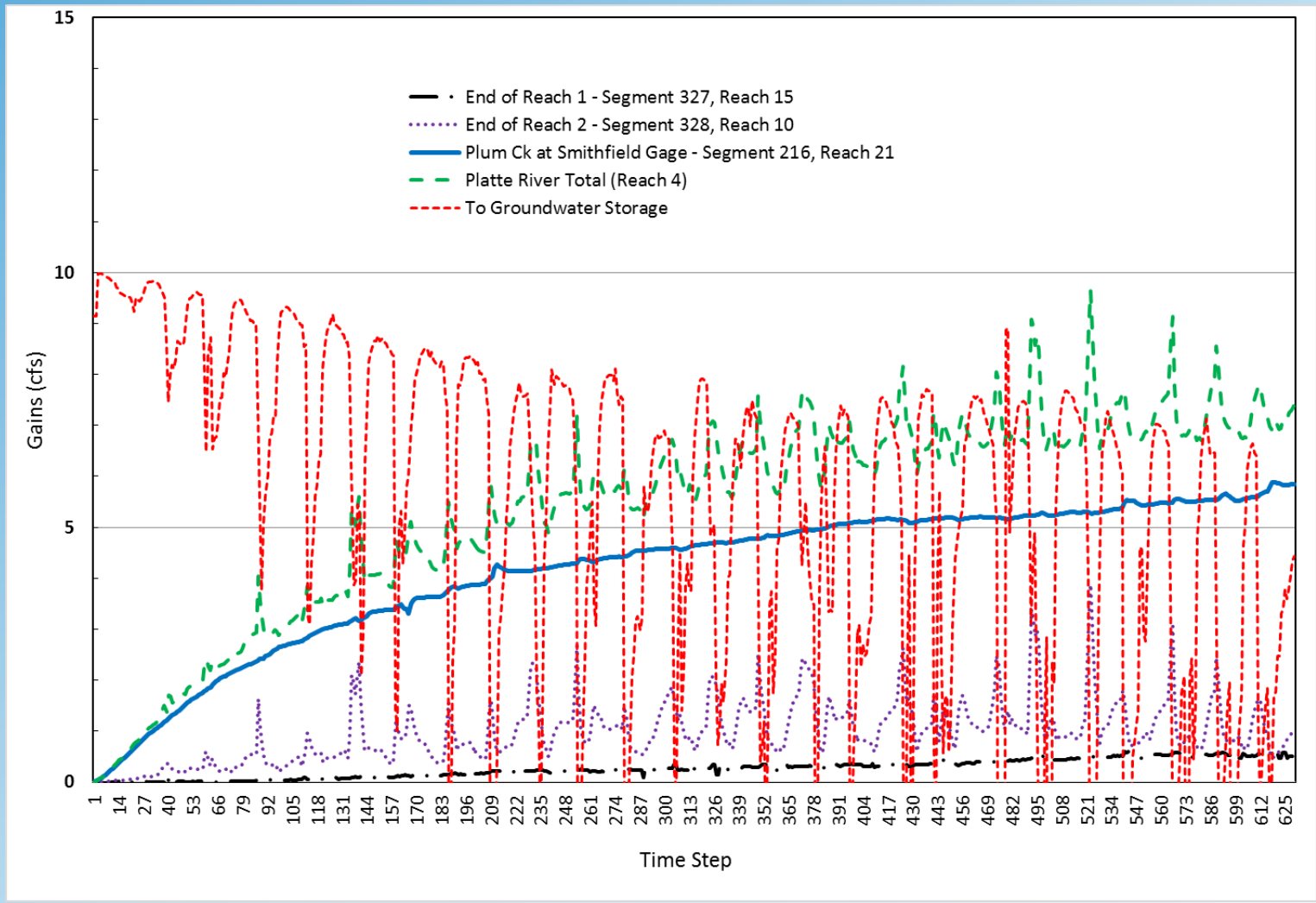

Model Prediction of Change in Flow for 10 CFS Recharge

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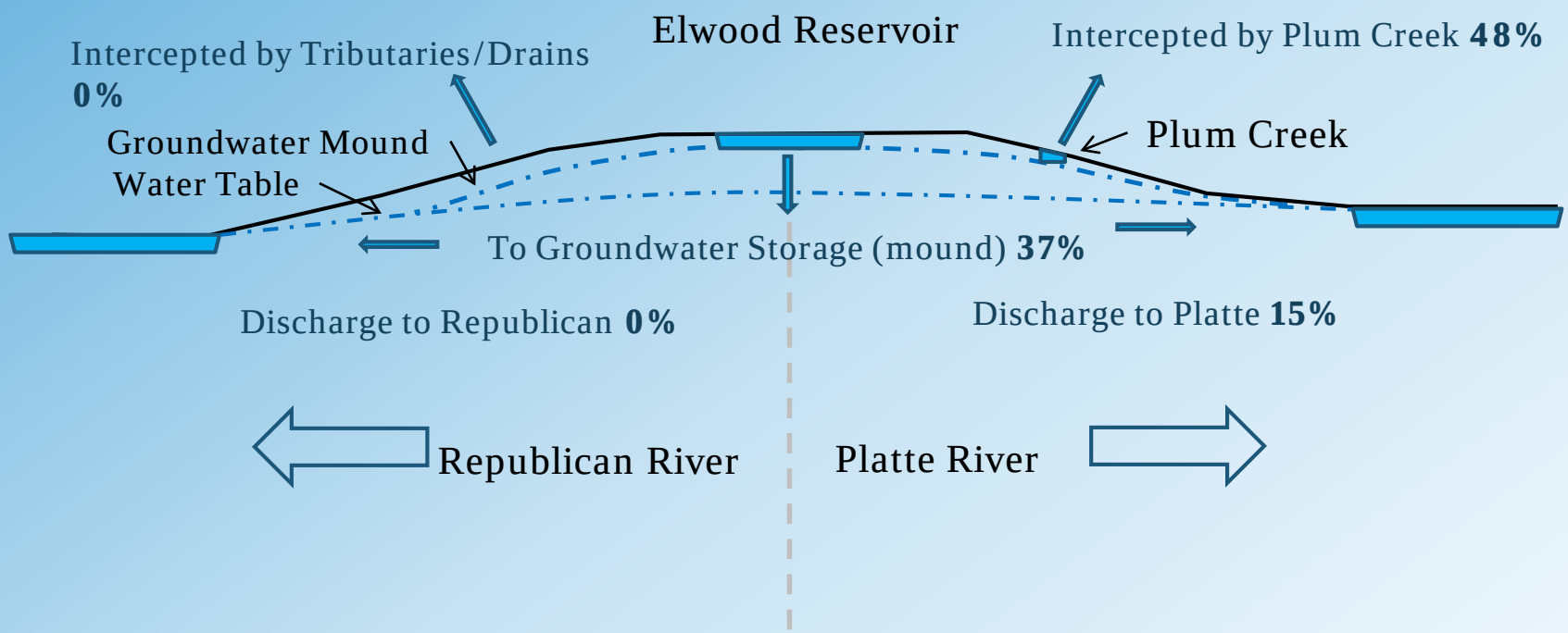

Where Do Return Flows Go?

(20 yrs, 10 cfs)

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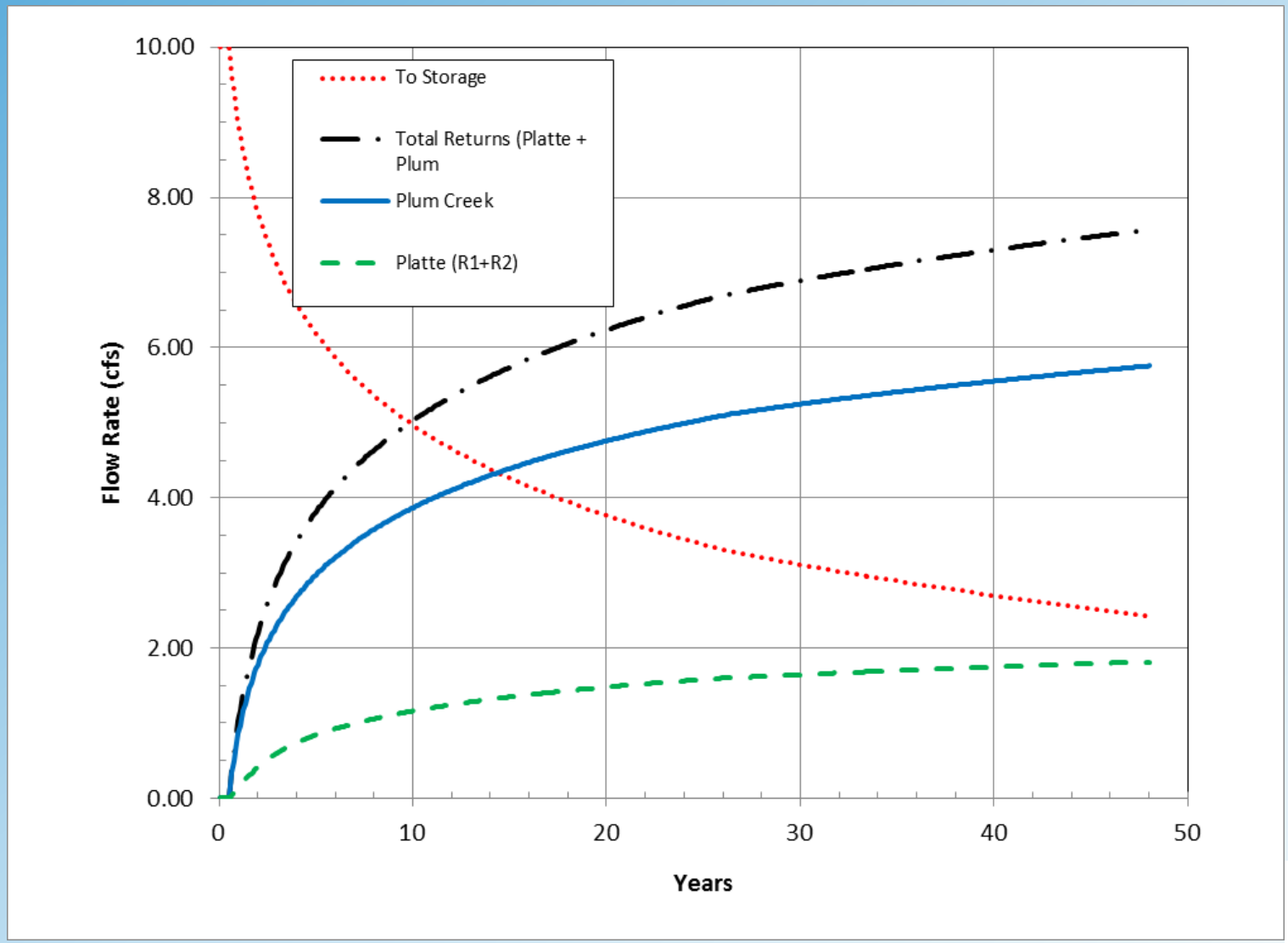

48-Year Return Flows and Flows to Groundwater Storage
10 CFS Recharge

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Accounting for Program Water Delivered to Elwood Reservoir

May 2015 through August 2017 (28 months)
(rounded)

Total Program Water Delivered to Elwood Reservoir (AF)	Total Loss of Program Water from Elwood (AF)	Water Returned via Platte R. (AF)	Water Returned via Plum Ck. (AF)	Water to Groundwater Storage (AF)
22,800	16,400	400	1,600	14,400

Water remaining in reservoir storage = 6,200 AF (22,800 – 16,400)

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Conclusions

- COHYST proved to be a useful tool for this analysis
- The model shows larger returns to the Platte than originally assumed (>50%)
- Significant amount of recharged water remains in storage (and will for quite some time)

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Scoring Status

- COHYST GW modeling completed
- EDO finalizing scoring calculations
- Begin review with scoring subcommittee in Feb-Mar timeframe
- Future availability of Elwood Reservoir

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Questions/Comments?

HAHN WATER RESOURCES, LLC

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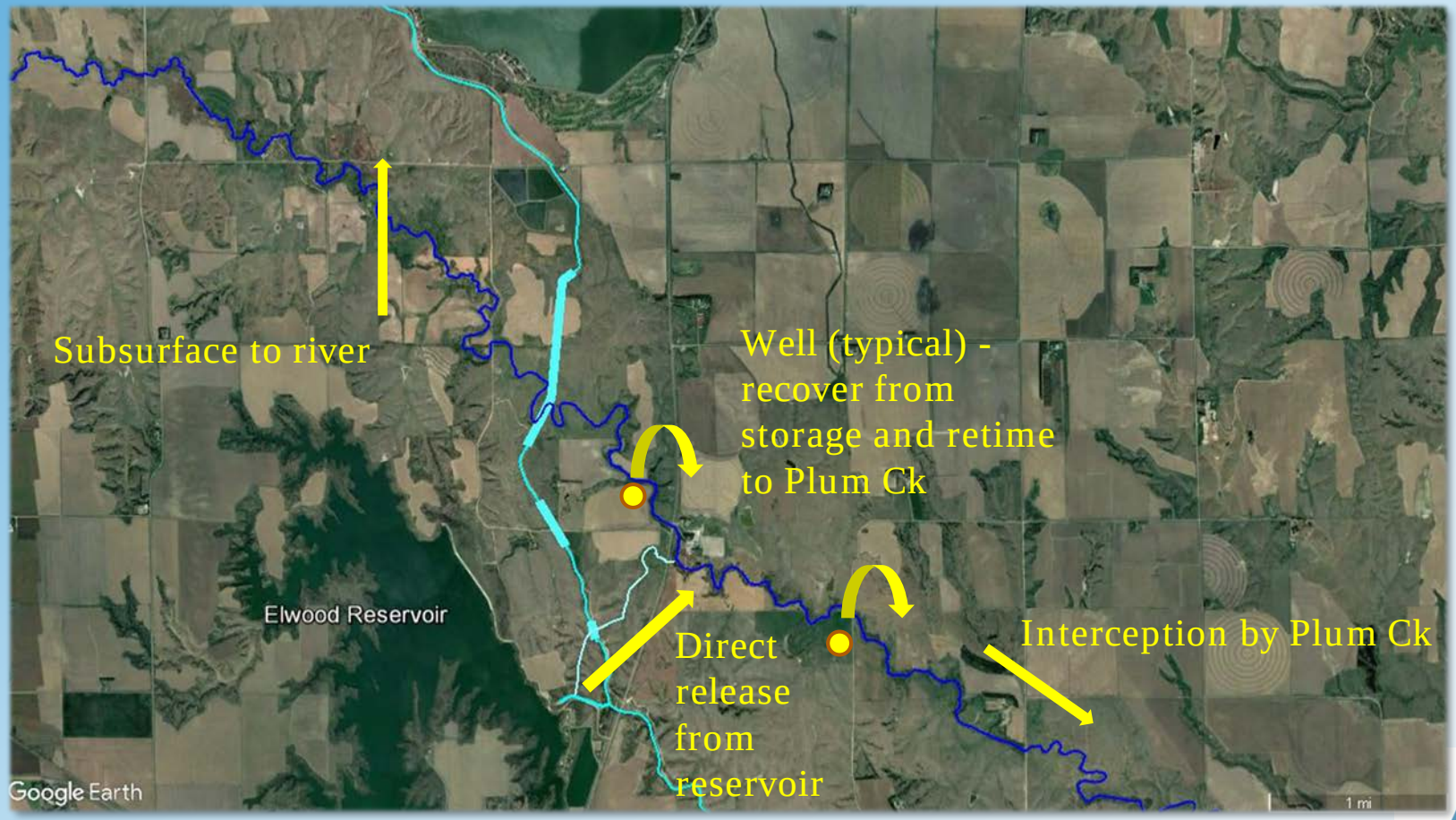
Storage Release, Retiming and Recapture Concept



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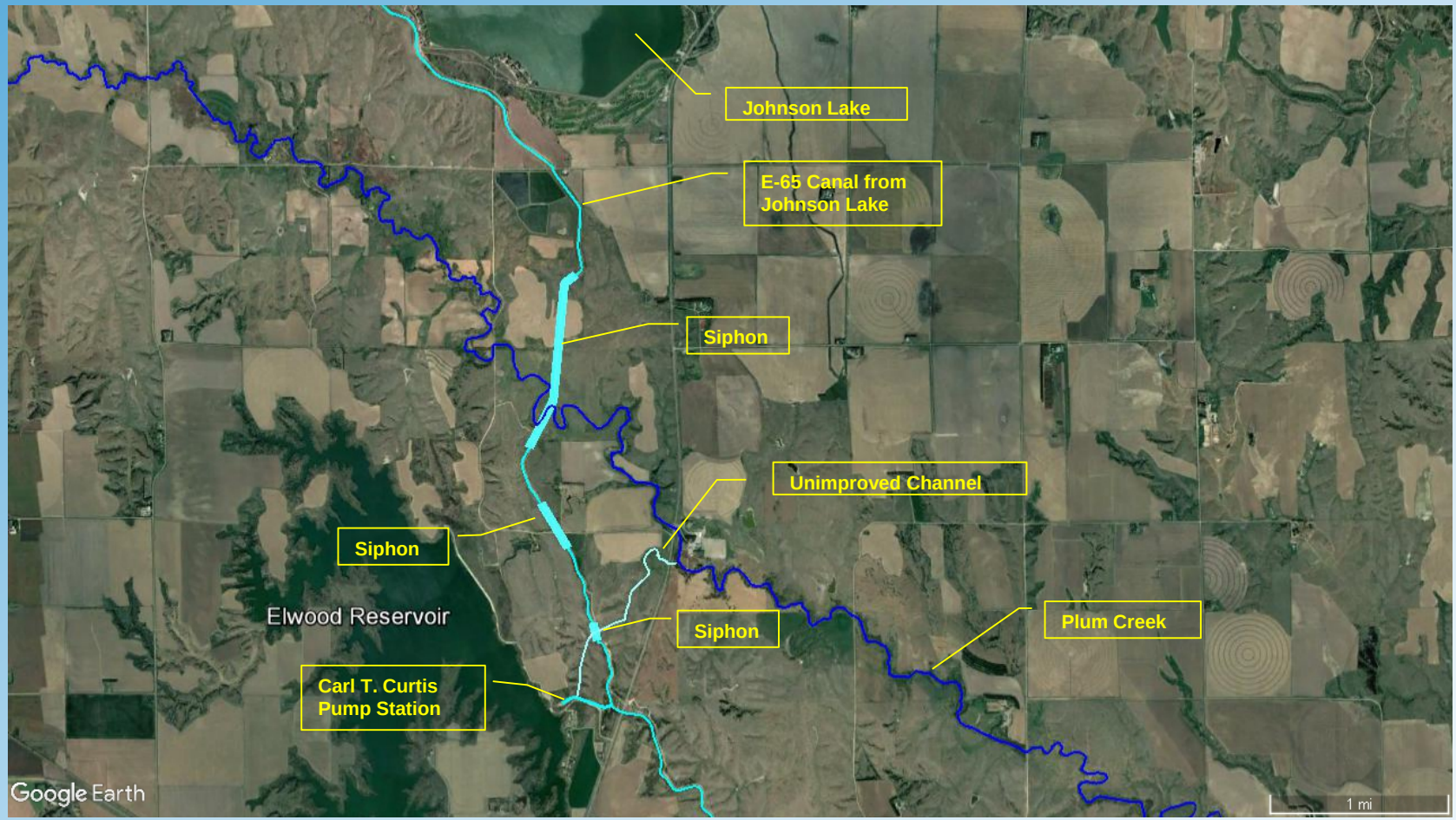

Elwood Reservoir Project Area

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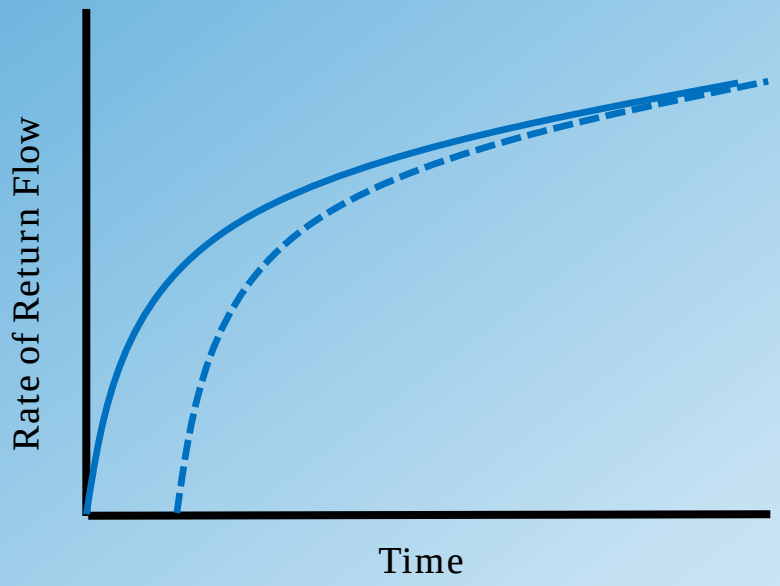

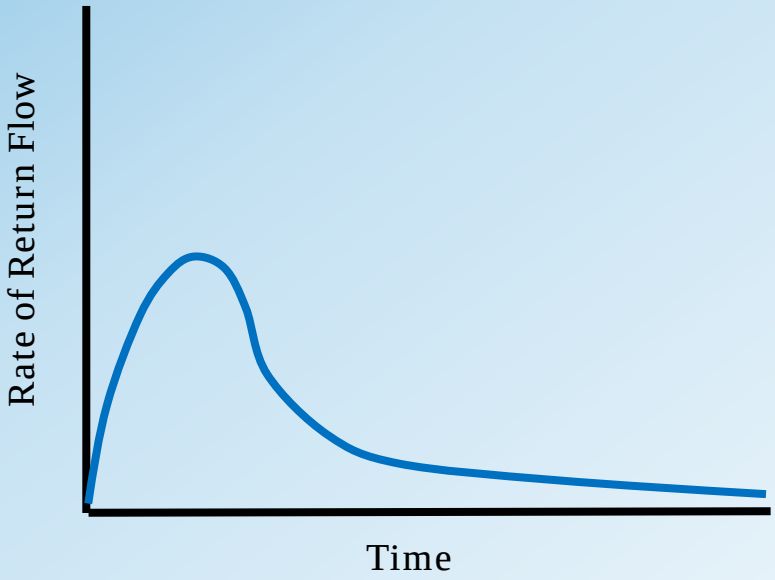

Calculating Return Flows for a 1-Month Pulse

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Project Site Screening

PRRIP Water Advisory Committee
February 6, 2018

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Overview

- Identify objectives
- Review efforts completed in 2017
- Review site screening results
- Preview next steps

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Objectives

- Initial projects underway:
  - Cottonwood Ranch broad-scale recharge
  - Lakeside slurry wall gravel pit
- EDO objective:
  - Identify viable sites for future BSR and gravel pit projects
- Study area:
  - Includes entire Platte Valley from Brady to Odessa

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RECOVERY IMPLEMENTATION PROGRAM

Collaboration with CPNRD

- EDO working with CPNRD to identify mutually beneficial projects
- Meetings in February and July 2017
  - Identified potential project sites
  - Discussed site attributes, known ownership
- Developed long list of 24 sites sourced from:
  - EDO
  - CPNRD
  - Previous feasibility studies for Program
  - Other evaluation reports

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RECOVERY IMPLEMENTATION PROGRAM

Initial documentation

- Hahn Water Resources memos
  - Drafts prepared for EDO in June and July 2017
  - Reviewed soils mapping, subsurface geology from drill holes
  - Looked for sites favorable to recharge (very few in valley with > 10 ft to groundwater)
  - Annotated long list of potential sites

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Narrowed focus

- Re-time surface water transferred from CPNRD canals

Net Surface Water Transfer from CPNRD Canals, 2015-2017

Canal	2015 Net Transfer [AF]	2016 Net Transfer [AF]	2017 Net Transfer [AF]	Three-Year Average [AF]
Thirty Mile	5,200	4,900	3,800	4,600
Cozad	9,200	9,800	9,300	9,400
Orchard-Alfalfa	1,400	1,000	700	1,000
Total	15,700	15,800	13,800	15,100

- Water available during irrigation season
  - 2.5-3 month window (late June-early September)
  - Flows generally higher, fewer shortages
  - Less value to Program
- EDO seeks to improve project score

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Site screening considerations

- Existing gravel pit lakes
  - Opposite side of river from canal headgates
  - Require roadway, railway, and land crossings (more expensive delivery infrastructure)
  - Existing recreation, residences, wetlands
- New gravel pits
  - Design of Lakeside pit underway (cost estimate greater)
  - Expected to take years to mine out Stall, Lindstrom pits (limited demand for materials)
- Sites requiring deliveries through NPPD or CNPPID canals
  - Eliminated 10 sites due to focus on re-timing CPNRD water
  - May be re-evaluated in other contexts

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Narrowed focus (again)

- Pursue (broad-scale) recharge projects only
  - Less efficient than gravel pits
  - Less direct control of water
  - BUT quicker and less expensive to design and construct
  - Preferred by CPNRD
  - Incorporate recapture wells

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Site screening

- Short list of 14 potential recharge sites evaluated
  - Thirty Mile (4 sites)
  - Cozad (5 sites)
  - Orchard-Alfalfa (5 sites)
- 8 sites eliminated
  - Too small
  - Too far from river
  - Very long return path even if recharged water pumped into surface stream (e.g., Spring Creek, Buffalo Creek)
  - Best fit – nearby sites larger, more accessible for deliveries from canals, more favorable return paths

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Dry Canyons

- Located between Thirty Mile Canal and Tri-County Supply Canal
- 2 were evaluated in 2008-2009 WMS for Program
  - Eliminated due to inadequate release capacity for SDHF
- 2 others located in between have potential
- EDO summary memo in December 2017
- EDO budgeted $100,000 for feasibility assessments in 2018
  - Working with Special Advisors to identify information, data needs

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Site screening results

Summary of project sites recommended for further evaluation

Project Site	Source of Supply	Project Type	Total Area [acres]	Volume [AF]	Means of Return to Platte River
Site B	Thirty Mile Canal (upper end)	Recharge	2,200	TBD	baseflow accretions and/or recapture wells
Complex including Sites A and C	Thirty Mile Canal (tail end)	Recharge	1,000	TBD	baseflow accretions and/or recapture wells
Site H	Cozad Canal (upper end)	Recharge	740	TBD	baseflow accretions and/or recapture wells
Complex including Sites X and D	Orchard-Alfalfa Canal (tail end), Thirty Mile Canal (tail end), Cozad Canal surface returns	Recharge	1,400	TBD	baseflow accretions and/or recapture wells
Dry Canyons (Gallagher, North Plum Creek, 2 unnamed)	Thirty Mile Canal	Dam (surface storage)	221 (NPC only)	2,320 (NPC only)	Releases from storage into Thirty Mile Canal; baseflow accretions from seepage

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RECOVERY IMPLEMENTATION PROGRAM

Recent and next steps

- Recent steps
  - Draft memo for EDO/CPNRD review in January 2018
  - Call to discuss initial reactions on February 1
- Next steps
  - EDO/CPNRD meeting in mid-March
  - Identify priority sites
  - Initiate land investigations
  - Dry Canyons feasibility

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Questions?

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RECOVERY IMPLEMENTATION PROGRAM

WAP Projects Status Update

PRRIP Water Advisory Committee
February 6, 2018

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RECOVERY IMPLEMENTATION PROGRAM

Overview

- WAP projects timeline
- WAP projects scoring
  - Current approved scores
  - Scoring work plan for 2018
  - Anticipated future scores
- Major WAP tasks for 2018
- Streamflow forecasts

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

Project timelines (1)

- Cottonwood Ranch broad-scale recharge
  - Design complete, permitting initiated early 2018
  - Construct 2018 (late summer, early fall)
  - Full operation in early 2019
- Full-scale slurry wall storage projects
  - Initial project (Lakeside)
    - Fieldwork and design in 2018
    - Permitting and construction in 2019
    - Full operation in early 2020
  - Site 2 (Stall): 2022-2024
    - Land purchased in 2017, then swapped with miner
    - Mining permitting initiated
  - Site 3 (Lindstrom): 2023-2025
    - Land purchased in 2016
    - Dryland farmed for now

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Project timelines (2)

- CNPPID recharge enhanced
  - Additional recapture wells for Phelps and Elwood
  - In place by end of 2018 or early 2019
- CPNRD recharge/leasing enhanced
  - Add storage or recharge to re-time surface water river returns to times of shortage
  - Site screening work throughout 2017
  - Land in place by 2019 (3-4 sites)
  - Phased construction of recharge or storage projects 2020-2024
- NPPD recharge/leasing enhanced
  - 2020-2024 timeframe

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Project timelines (3)

- Acquire & Retire
  - 2016-2024 timeframe
- Additional land for water projects identified or in process of acquisition by end of 2o19

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Project timelines (4)

Projected timeline for completion of WAP projects with cumulative scores of 40,000 AFY or greater										
Project	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Land acquisition for water projects (e.g., slurry wall storage, BSR, etc)	■	■	■	■	▨					
Broad-scale recharge at Cottonwood Ranch	■	■	■	■	■					
Preliminary fieldwork (infiltration testing, geophysical surveys, etc.)	■									
Design and permitting		■	■							
Construction and operation			■	■						
Initial slurry wall storage (Lakeside pit)	■	■	■	■	■					
Preliminary fieldwork (borehole testing, etc)	■									
Fieldwork and design			■							
Permitting			■	■						
Construction and operation				■	■					
Additional slurry wall storage		▨	▨	▨	▨	▨	■	■	■	■
Site 2 (Stall)							■	■	■	
Site 3 (Lindstrom)								■	■	■
CNPPID recharge enhanced (e.g., addt'l recapture wells for Phelps, Elwood)			■	■						
CPNRD recharge/leasing enhanced		▨	▨	▨	■	■	■	■	■	
NPPD recharge/leasing enhanced					■	■	■	■	■	
CNPPID irrigator leasing	■	■	■	▨	▨	▨	▨	▨	▨	▨
Acquire & Retire	■	■	■	■	■	■	■	■	■	

▨ Indicates tentative time, e.g., a project may extend this long, or there may be an initial period of waiting for land acquisition in order to proceed.

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Approved WAP scores

- Pathfinder Municipal Account Lease (4,000 AFY)
- Phelps County Canal Groundwater Recharge (2,700 AFY)
- No-Cost NCCW score = 260 AFY
- Cook well score = 160 AFY
- **Present score total = 7,120 AFY**

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Scoring work plan for 2018

- Complete CPNRD recharge/leasing score
  - As presently operated (update when enhancements added)
  - Preliminary estimate = 2,600 AFY at 50% Program credit
  - Anticipated for June GC
- Elwood Reservoir recharge
  - As presently operated (update when enhancements added)
  - Groundwater model completed
  - Preliminary estimate = 6,000 AFY
  - Anticipated for June GC
- NPPD groundwater recharge through Gothenburg and Dawson County canals
  - Anticipate starting later in 2018
  - Conceptually similar to Phelps recharge
  - Separate from NPPD surface water leasing (if/when permits approved)

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Score estimates

Project	Score Estimate* [AFY]
Pathfinder lease (assume renewed; approved score)	4,000
No-Cost NCCW (approved score)	260
Phelps recharge w/ addt'l wells (includes 2,860 AFY approved score)	3,000
Broad-scale recharge at Cottonwood Ranch	6,000
Elwood recharge w/ addt'l wells	6,000
CPNRD recharge/leasing enhanced	10,000
NPPD recharge/lease enhanced	2,500
CNPPID irrigator leasing	1,600
Slurry wall storage (multiple sites)	8,000
Acquire & Retire	2,500
TOTAL =	**43,860**
*Score values that are not yet approved are approximations based on present plans and SUBJECT TO CHANGE.	

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Major WAP tasks for 2018

- Cottonwood Ranch BSR permitting and construction
- Lakeside gravel pit design and permitting
- Continued operation of leasing and recharge projects with CPNRD, CNPPID, and NPPD
- Phelps and Elwood recapture wells
- CPNRD and Elwood scoring
- CPNRD recharge site assessments
- Dry Canyons feasibility
- Osborne property irrigation flow measurements
- Accounting updates
- Operations modeling

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WY 2018 Seasonal Forecasts

- Developed by Special Advisor Dmitry Smirnov at Dewberry
- http://54.215.135.182/Platte_River_Forecast/
- Most locations average to below average

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Questions?

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PRRIP AEM Surveys Completed During 2016

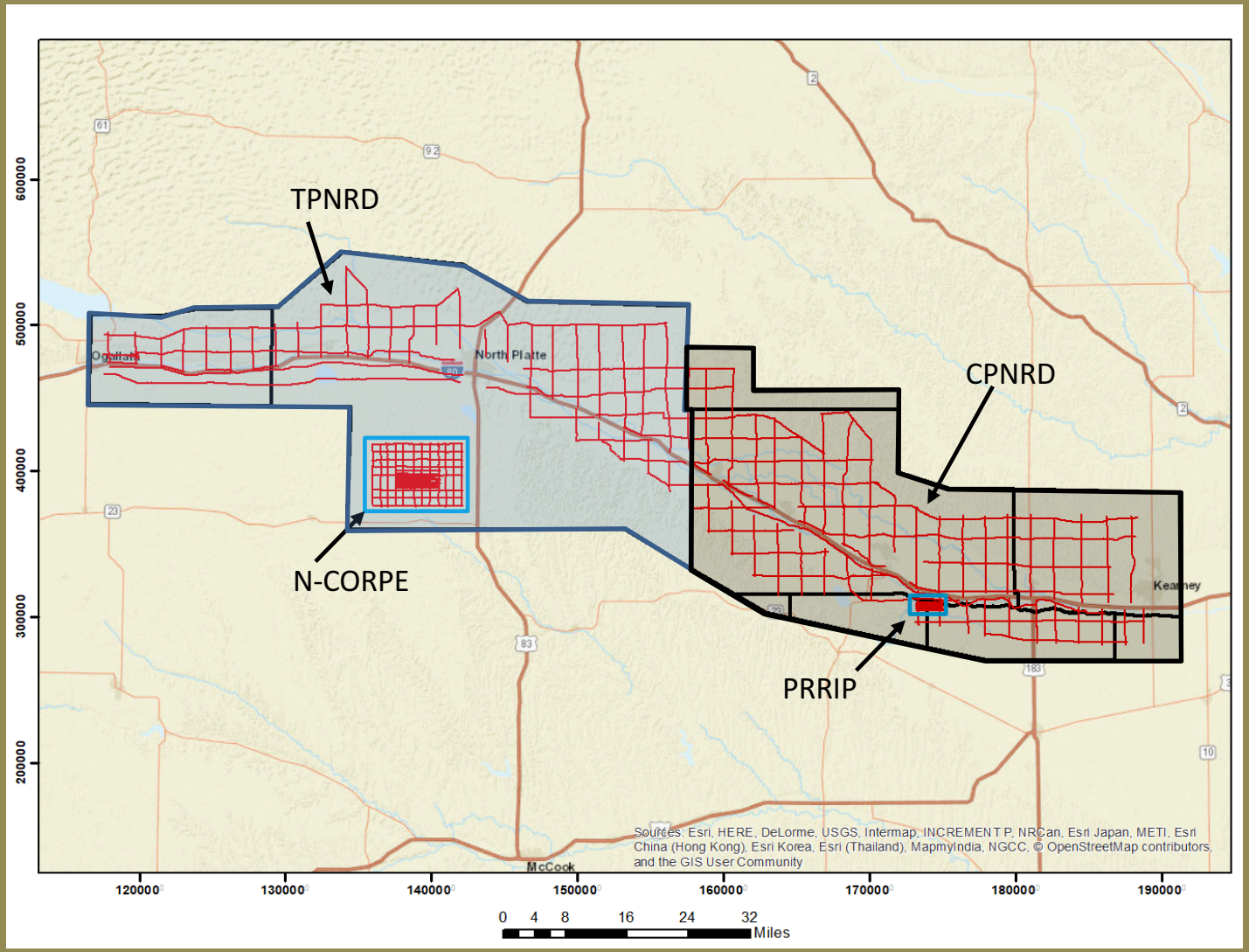
Aqua Geo Frameworks, LLC

Mitchell, NE

James C. Cannia, Senior Geologist, P.G.

Jared D. Abraham, Senior Research Geophysicist, MSc., P.G.

Ted Asch, Senior Research Geophysicist, Ph.D, P.Gp.



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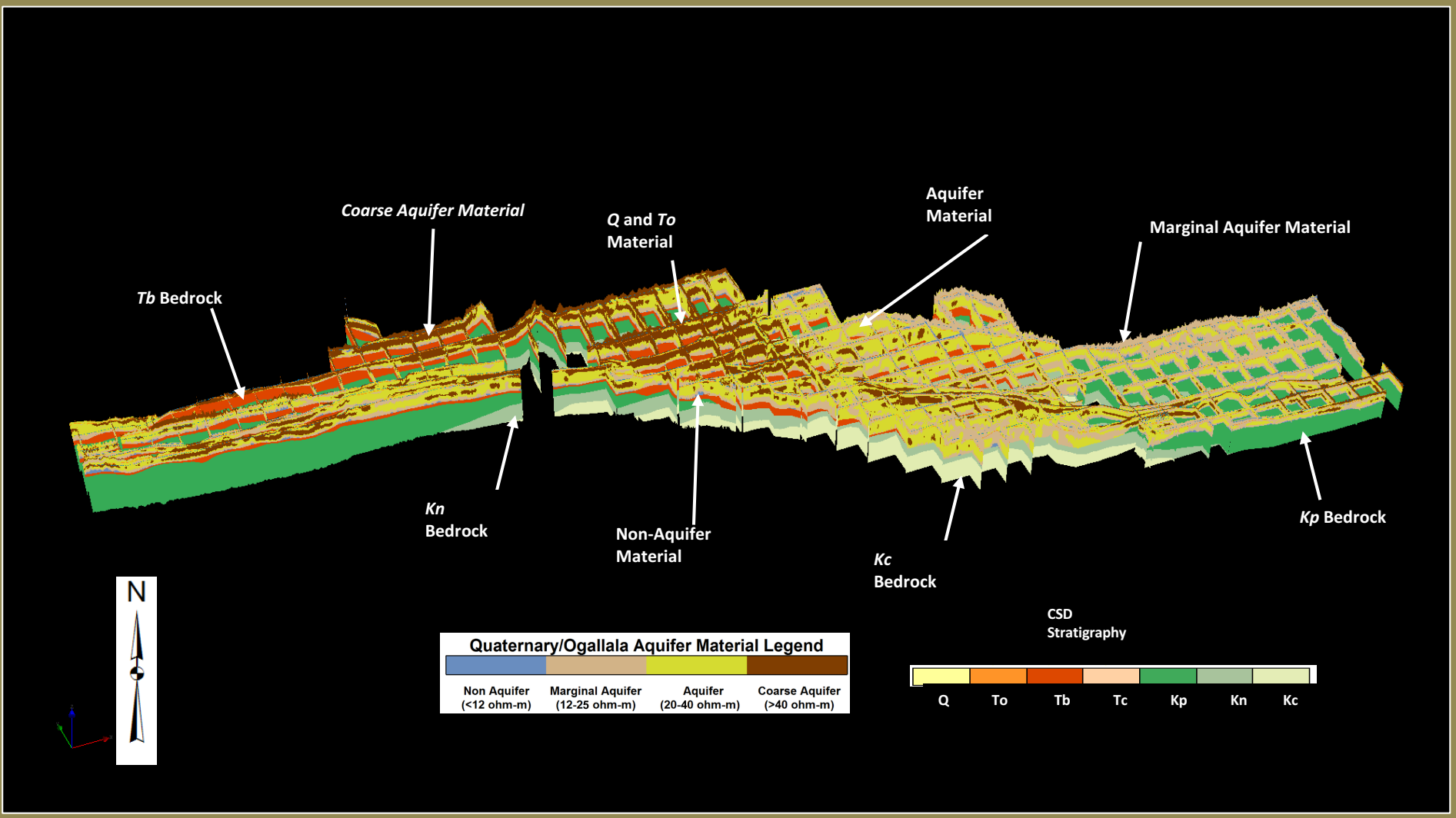

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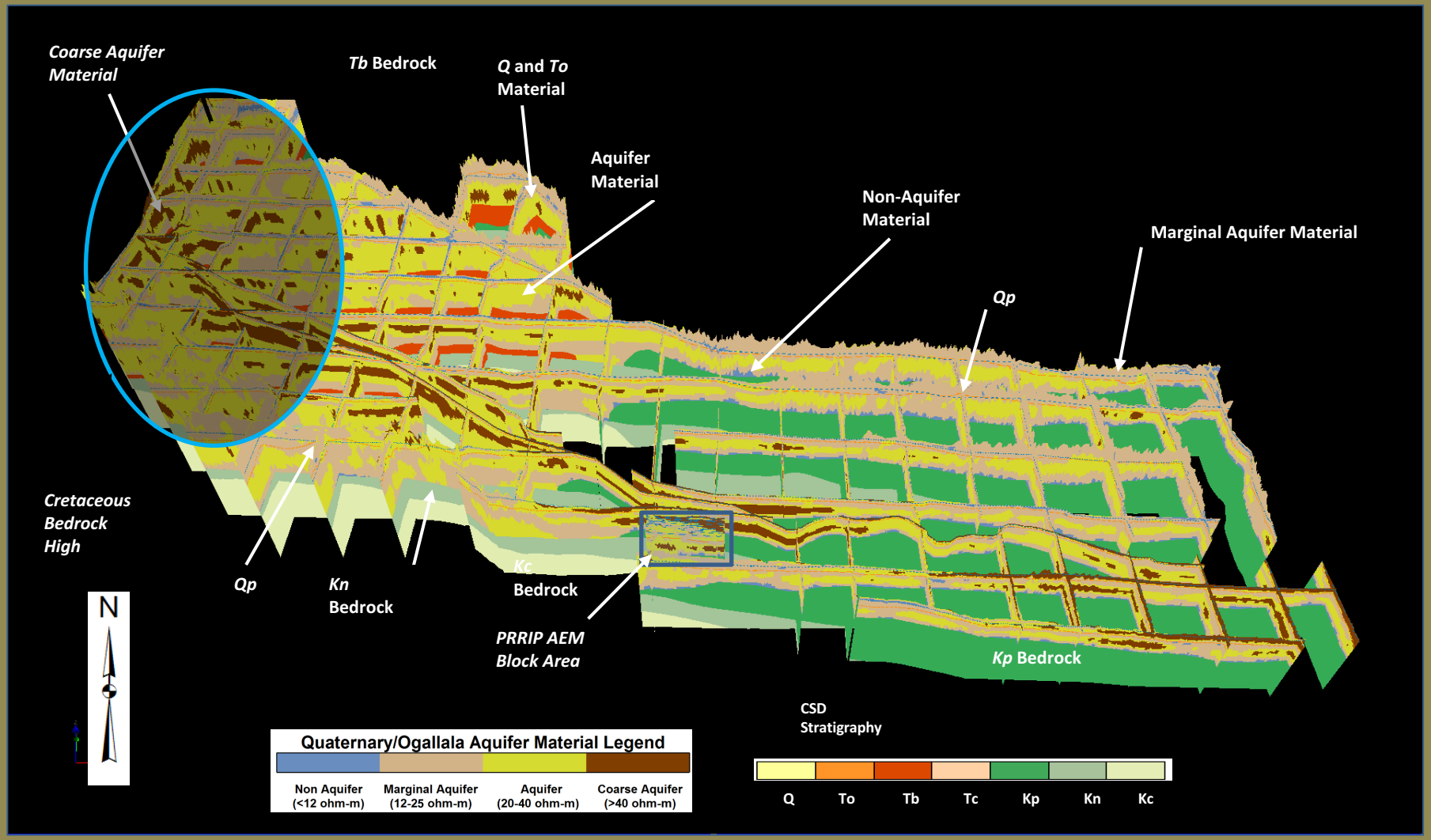

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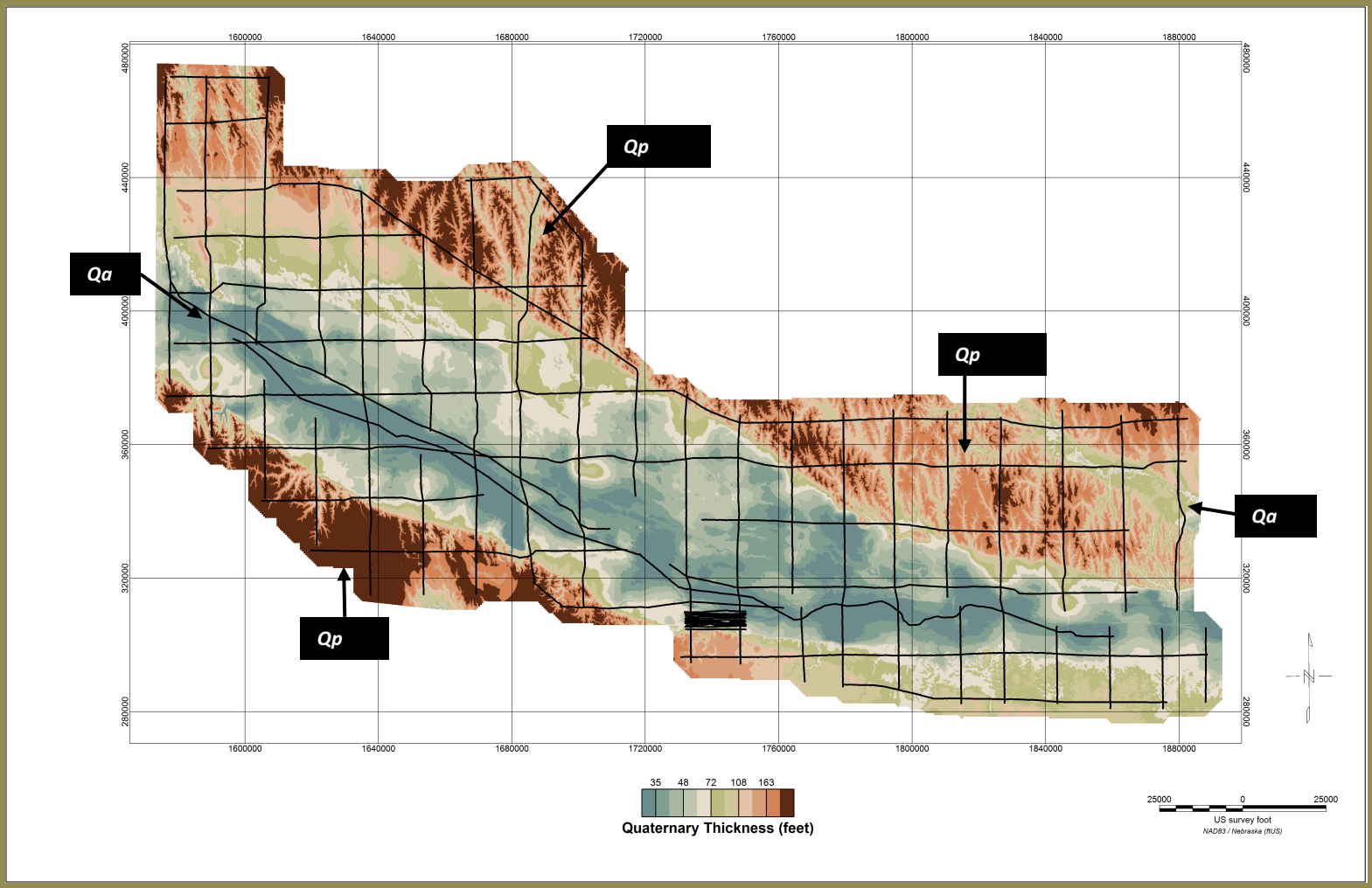

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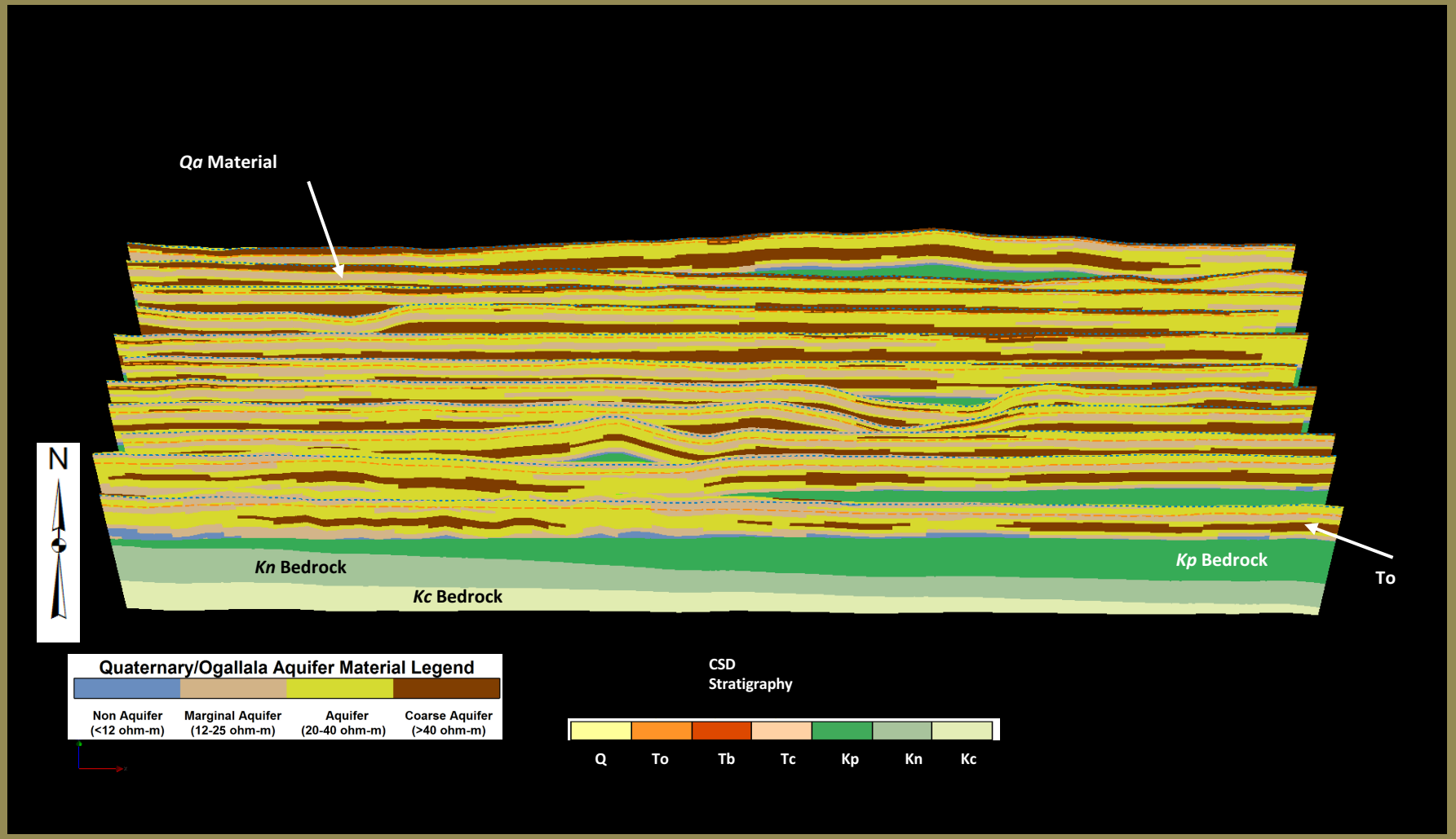

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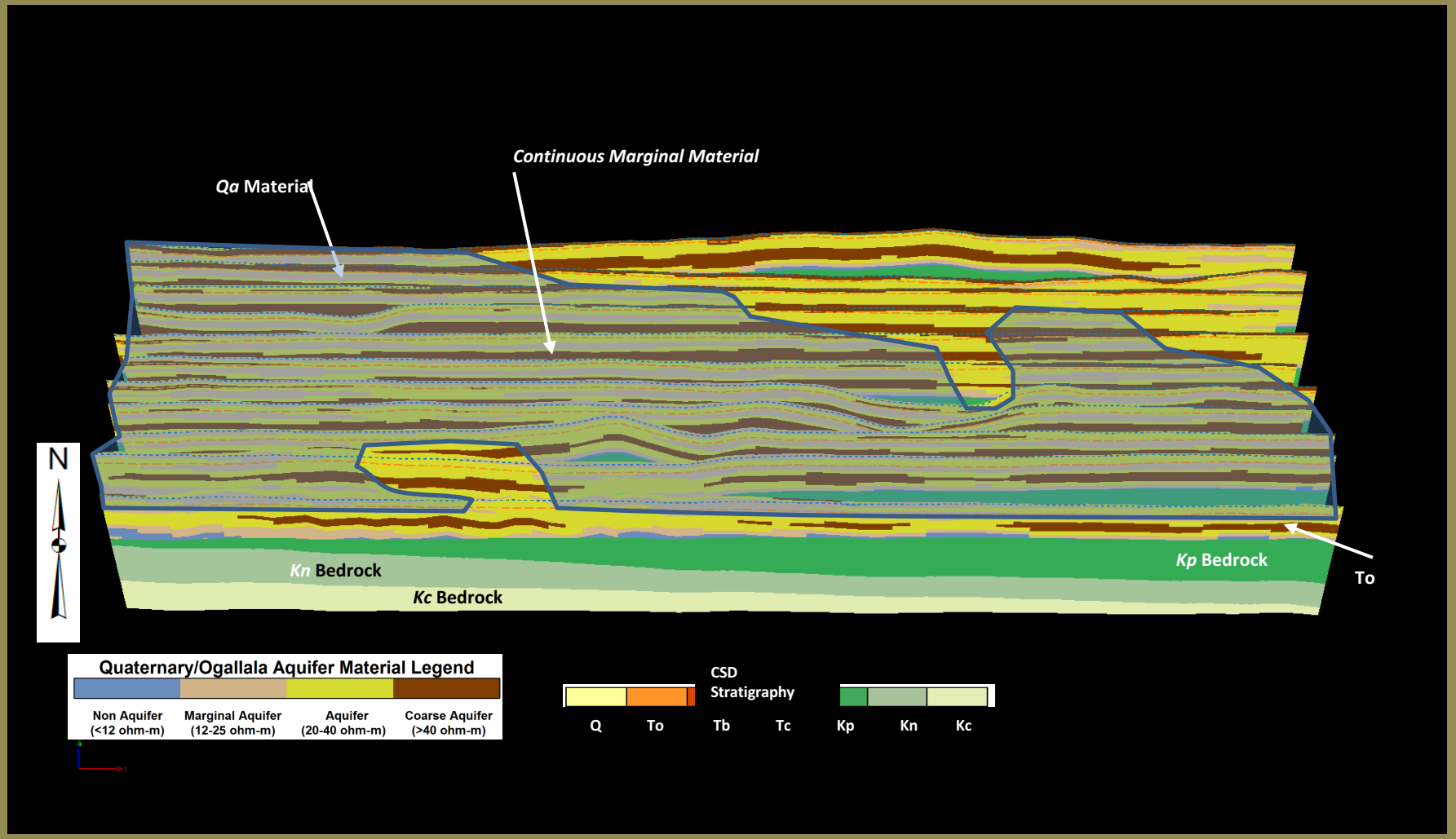

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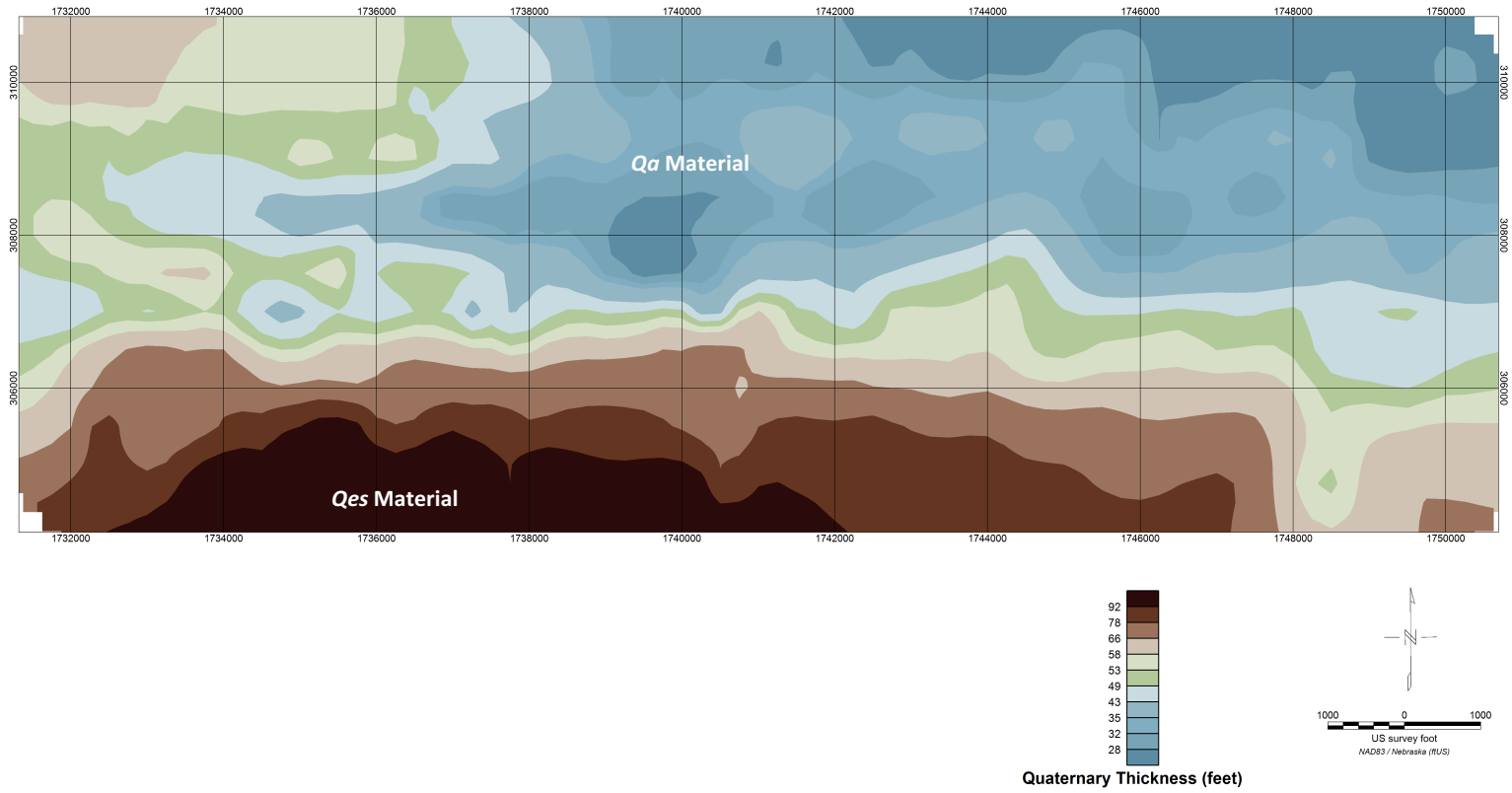

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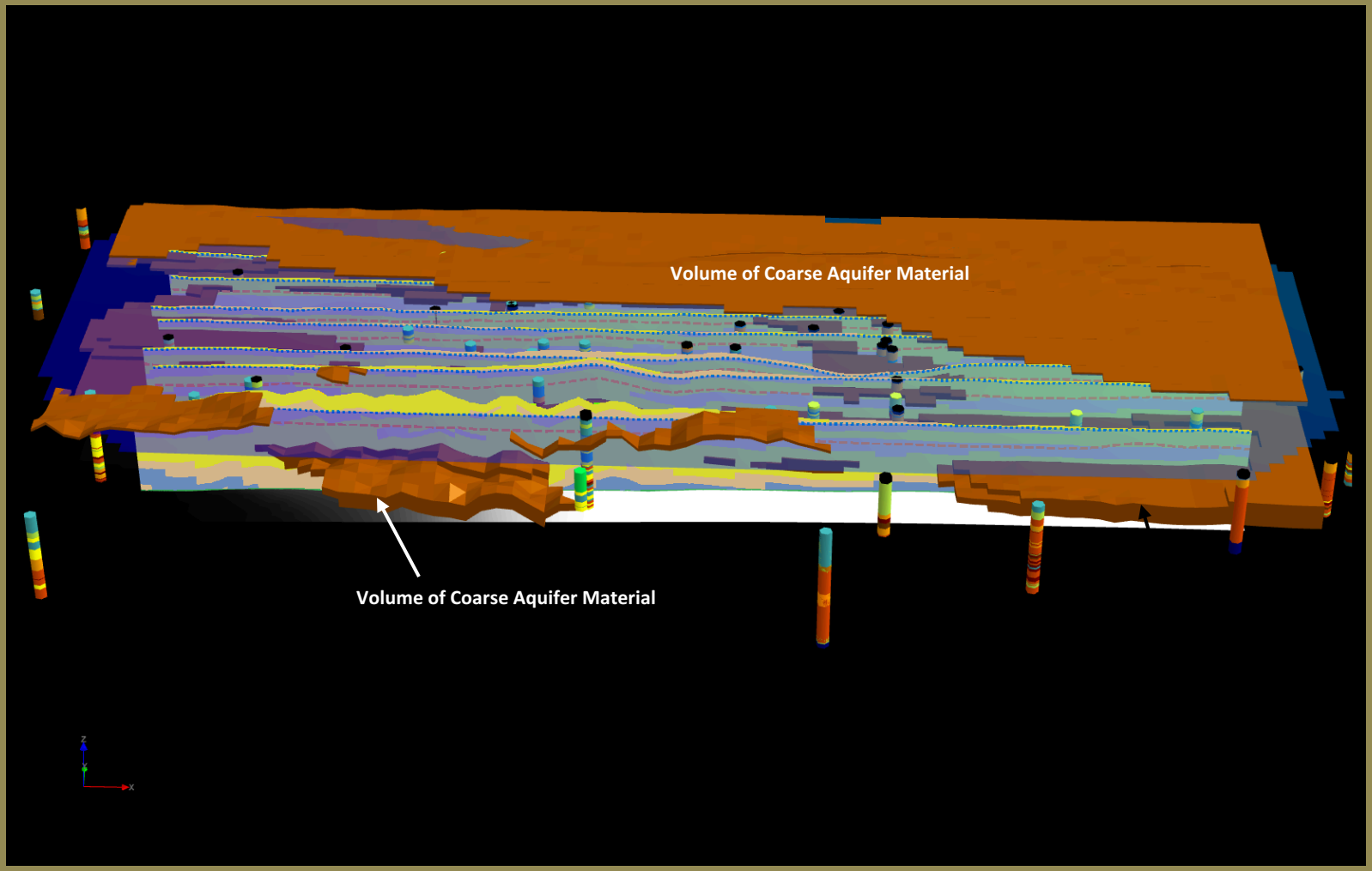

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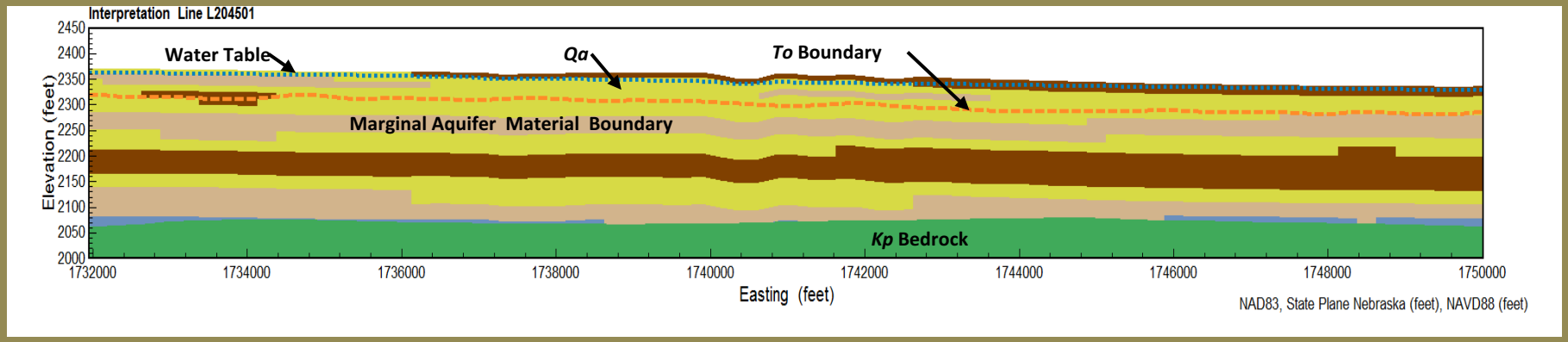

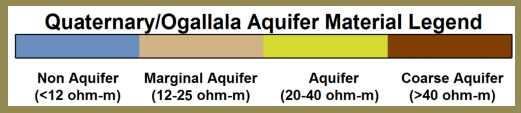

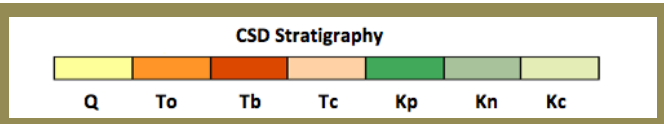

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Table 5-5 Saturated *Q* and *To* aquifer materials underlying the PRRIP block flight AEM survey area.

Aquifer Material Type	Aquifer Volume (ft^3)	Aquifer Volume (acre-ft)	Average Porosity	Groundwater in Storage Volume (acre-ft)	Average Specific Yield	Extractable Water Volume (acre-ft)
Non-Aquifer	2,610,470,000	59,928	0.40	23,971	0.02	479
Marginal	13,216,821,500	303,416	0.35	106,195	0.05	5,309
Aquifer	18,893,189,500	433,727	0.20	86,745	0.22	19,083
Coarse	11,189,771,250	256,881	0.25	64,220	0.19	12,201
TOTAL	45,910,252,250	1,053,954		281,131		37,072

AGF Aqua Geo Frameworks

Discussion and Questions?

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