North Fork Kings
Groundwater Sustainability Agency

Groundwater Sustainability Plan (GSP) Status Report

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BOARD OF DIRECTORS MEETING

JANUARY 23, 2019

RIVERDALE COMMUNITY EDUCATION CENTER

Presentation Overview

1. Schedule
2. GSP Development Update
3. Kings Subbasin Coordination Update
4. Achieving Sustainability
    - Potential Projects
    - Management Actions
    - Undesirable Results
5. Monitoring Network
6. Water Quality Characteristics
7. Water Budget

EST. 1955
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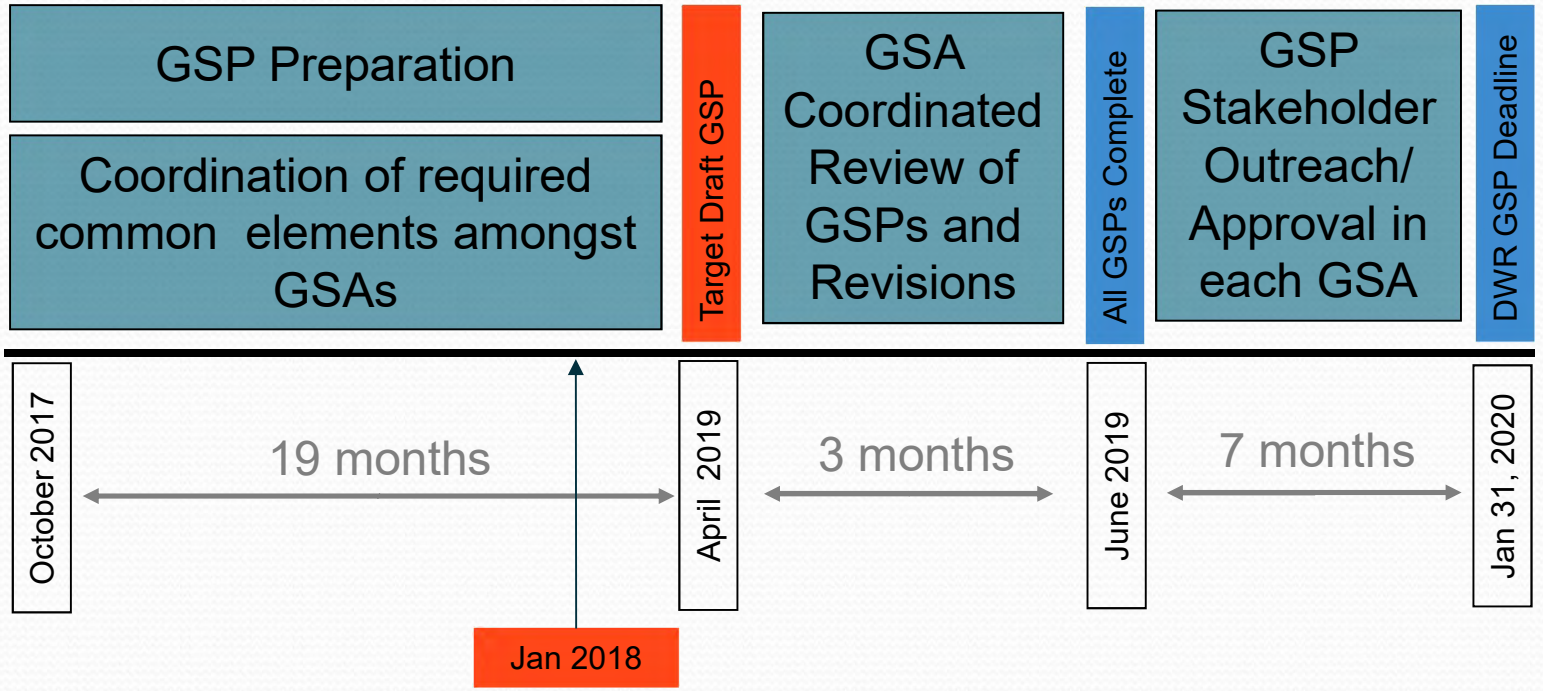

GSP Preparation and Coordination Timeline

GSP Development Update

GSP Section	Current Status	Future Work
2- Plan Area	Draft Complete - Provided to Technical Advisory Group and Rural Community Advisory Committee for review	Incorporate comments and provide to Board of Directors
3.1 - Hydrogeologic Conceptual Model	Internal Draft Nearly Complete	Complete draft, then provide to TAG and RCAC for review in mid-February
3.2 – GW Conditions	In Progress – nearing completion on water quality analysis	Complete draft, then provide to TAG and RCAC for review in mid-February
3.3 – Water Budget	In Progress – data gathering nearly complete	Complete draft, then provide to TAG and RCAC for review in late February
4 - Sustainable Management Criteria	In Progress, developing criteria for water levels	Develop criteria, define undesirable results, set minimum thresholds and measurable objectives
5 – Monitoring Network	In Progress - data gaps identified, initiating chapter development	Complete draft, then provide to TAG and RCAC for review in late February
6 – Projects and Management Actions	In Progress – identifying potential projects and management actions	Complete draft, then provide to TAG and RCAC for review in March
7 – Plan Implementation	Not Initiated	Late March target date

Kings Subbasin Coordination Task Orders

All GSAs within Kings Subbasin working together to estimate current overdraft responsibility among GSAs and coordinate activities:

- Task 1 - project coordination and meetings
- Task 2 - groundwater conditions
- Task 3 - estimation of groundwater storage (unconfined)
- Task 4 - groundwater flow estimates
- Task 5 - confined aquifer boundary flow estimate
- Task 6 - data management system
- Task 7 - water budget
- Task 8 - DWR Technical Support Services Coordination
- Task 9 - Coordination Agreement Assistance
- Task 10 - Water Level Sustainable Management Criteria Coordination

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Kings Subbasin Coordination Update

- Evaluated several potential base periods to estimate “average” conditions for surface water deliveries, with assumed “average” groundwater pumping, base period of Spring 1997 to Spring 2012 selected
- Calculated historical storage change and impacts of groundwater flows to allocate responsibility for groundwater overdraft
- Kings Subbasin overdraft preliminarily estimated at 122,000 AF/yr during base period, with NFKGSA responsible for approximately 50,000 AF/yr
- Group acknowledges the numbers will change as additional information is obtained and will be re-evaluated in the future
- Kings coordination group working on remaining task order items
- Water budget for NFKGSA and Kings Subbasin will be useful in confirming estimated overdraft numbers

Achieving Sustainability

- Preliminary estimate of groundwater overdraft for NFKGSA is approximately 50,000 AF/yr
- There are basically only two ways to achieve sustainability and eliminate overdraft:
  - Increase water supply - primarily through project development
  - Reduce water demand – primarily through management actions
- Increasing water supply will be the emphasis, but there are hurdles:
  - Availability and frequency of additional water – likely Kings River floodwater – for groundwater recharge or direct use
  - Water rights – all Kings River water is allocated per established schedule
  - Physical constraints – soils conducive for recharge, distribution system, etc.
- Demand reduction through management actions will likely be initiated after 5 years if project development isn't progressing as needed

Potential Projects

- Preliminary project list contains 9 groundwater recharge projects that would yield an estimated annual average of approx. 20,000 AF/yr based on historic floodwater availability
- Additional projects have been envisioned, but additional information is needed, such as:
  - Locating restrictive clay layers to better define potential recharge areas
  - Potential yield of newer technologies, such as reverse flow tile system
- The amount of overdraft that can't be overcome with increasing the water supply will need to be overcome with management actions that reduce water demand

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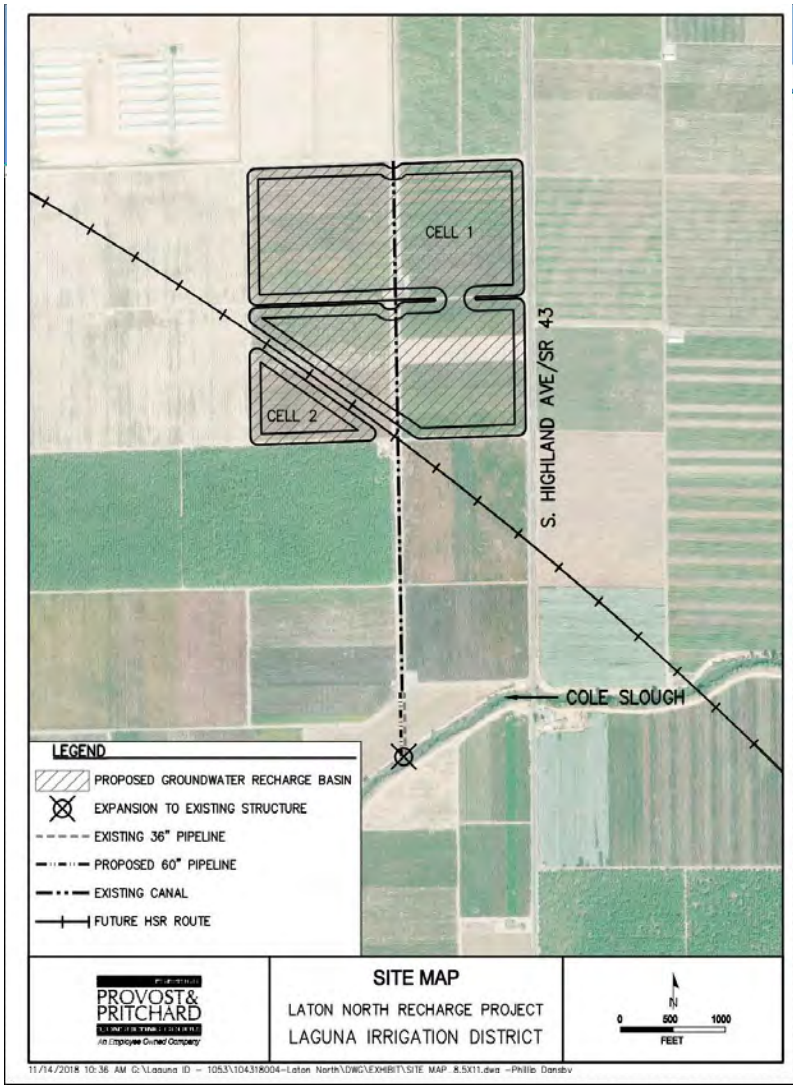

Proposed Recharge Project

- Laton North Recharge Project being pursued by Laguna Irrigation District
- Recharge basin to be excavated by High Speed Rail project
- Gross acreage = 150 ± acres
- Storage volume = 2,800 ± AF
- Estimated average annual recharge = 5,000 ± AF

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Potential Management Actions

- Management Actions are programs and policies that will aid the GSA in achieving sustainability primarily through water demand reduction measures and improving data monitoring
- A suite of potential management actions will be presented in the GSP that could be implemented at the GSA level or landowner level
- GSA may not want to dictate management actions at the landowner level, what works for one landowner may not work for another and economic impacts must be considered
- Need to establish the criteria and response to exceedances of minimum thresholds and undesirable results

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Sustainable Management Criteria

- Sustainability indicators

- Significant & Unreasonable – defined using the following:

Likely addressed in this order

- Undesirable Results
- Minimum Thresholds
- Measurable Objectives
- Sustainability Goal

Must be agreed to, and be consistent in the GSPs of all GSAs within basin

Undesirable Results

- Undesirable results occur when conditions related to any of the six sustainability indicators become significant and unreasonable
- Undesirable results will be used by DWR to determine whether the sustainability goal has been achieved within the basin
- Undesirable results will be defined by minimum threshold exceedances – at a single monitoring site, multiple sites, portion of basin, entire basin
- GSP must include a description for each undesirable result and define when an undesirable result is triggered
- Descriptions of undesirable results are to be coordinated with other GSAs within a basin

Possible Undesirable Results

Sustainability Indicators ->	**Lowering of Groundwater Levels**	**Groundwater Storage Reduction**	**Degraded Water Quality**	**Land Subsidence**	**Surface Water Depletion**
Metric ->	Groundwater elevation of wells	Volume withdrawn from an area	Water quality measurements	Rate and extent of land subsidence	Rate or volume of surface water depletion
Undesirable Results	Shallow supply wells go dry (mostly domestic)	Reduces reserve available for droughts	Contaminant plume migration	Interferes with surface land uses	Stream depletion
	Increased pumping costs for supply wells	Avail water less than operational flexibility	Additional treatment and monitoring costs	Infrastructure damage – roads, pipelines, canals	GW Dependent Ecosystem impacts
	Rehab costs (ex: deepen wells, lower pumps)		Potential inability to use supply wells	Supply well damage	Riparian Impacts
	Adversely change GW flow gradients		Impact on crop yields	Arsenic squeezed out of clays?	
	Causes land subsidence		Human health impacts	Reduces conveyance systems capacities	
	Adversely impacts water quality		Reduces available supply of water	Increased seepage and flooding risks	
	Stream depletion				
Groundwater elevation may be used as a proxy metric for all sustainability indicators.					

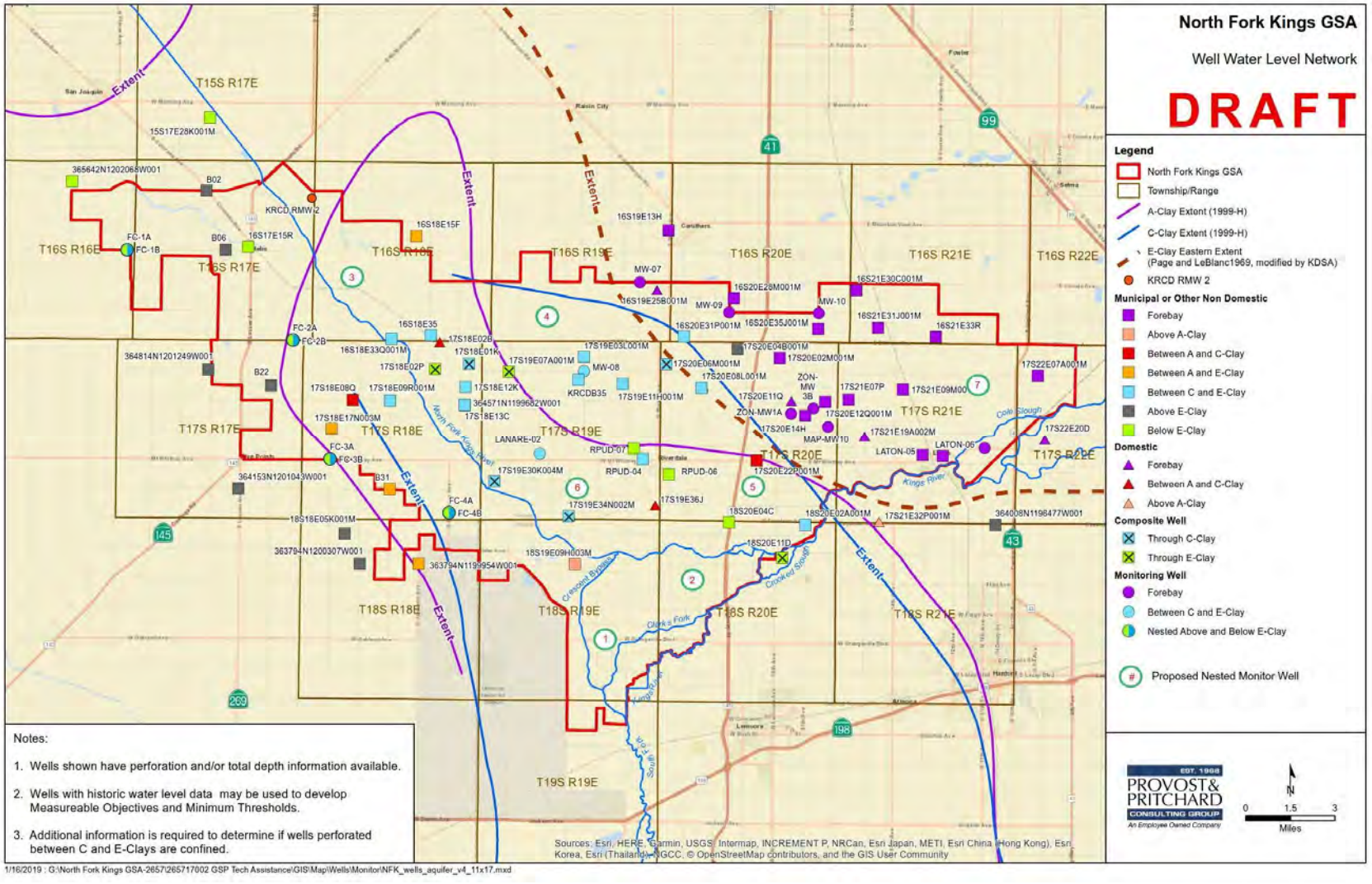
Must define going forward when these undesirable results become <u>significant</u> and <u>unreasonable</u> as a result of groundwater management actions.

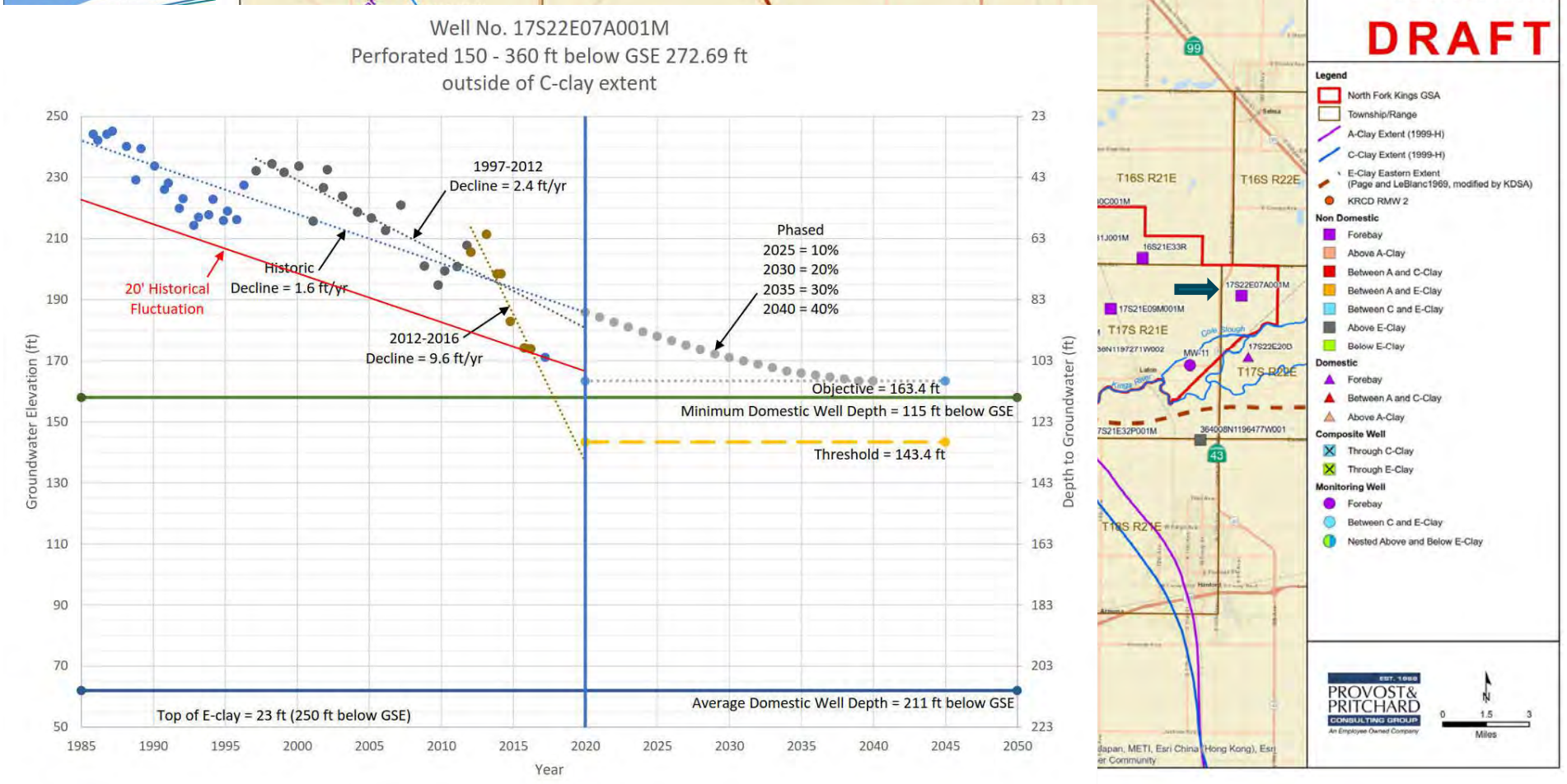
Groundwater Monitoring

- Monitoring network to be used to preliminarily establish sustainability criteria
- Monitoring is required to assess impacts on undesirable results
- Sub-areas may define different minimum thresholds and be operated to different measurable objectives
- Adequate monitoring requires knowledge of well depth and perforated interval in wells – need to know what aquifer well is pumping from
- Construct as many monitor wells through DWR TSS grant as possible
- May need to construct some shallow monitor wells along river system to fully assess surface water-groundwater interaction

Draft Monitoring Network

Proposed Dedicated Nested Monitor Wells




Well No. 17S22E07A001M
Perforated 150 - 360 ft below GSE 272.69 ft
outside of C-clay extent
Groundwater Elevation (ft)
Depth to Groundwater (ft)
Year
1997-2012
Decline = 2.4 ft/yr
Historic
Decline = 1.6 ft/yr
20' Historical
Fluctuation
2012-2016
Decline = 9.6 ft/yr
Phased
2025 = 10%
2030 = 20%
2035 = 30%
2040 = 40%
Objective = 163.4 ft
Minimum Domestic Well Depth = 115 ft below GSE
Threshold = 143.4 ft
Top of E-clay = 23 ft (250 ft below GSE)
Average Domestic Well Depth = 211 ft below GSE
North Fork Kings GSA
Well Water Level Network
DRAFT
Legend
North Fork Kings GSA
Township/Range
A-Clay Extent (1999-H)
C-Clay Extent (1999-H)
E-Clay Eastern Extent
(Page and LeBlanc1969, modified by KDSA)
KRCD RMW 2
Non Domestic
Forebay
Above A-Clay
Between A and C-Clay
Between A and E-Clay
Between C and E-Clay
Above E-Clay
Below E-Clay
Domestic
Forebay
Between A and C-Clay
Above A-Clay
Composite Well
Through C-Clay
Through E-Clay
Monitoring Well
Forebay
Between C and E-Clay
Nested Above and Below E-Clay
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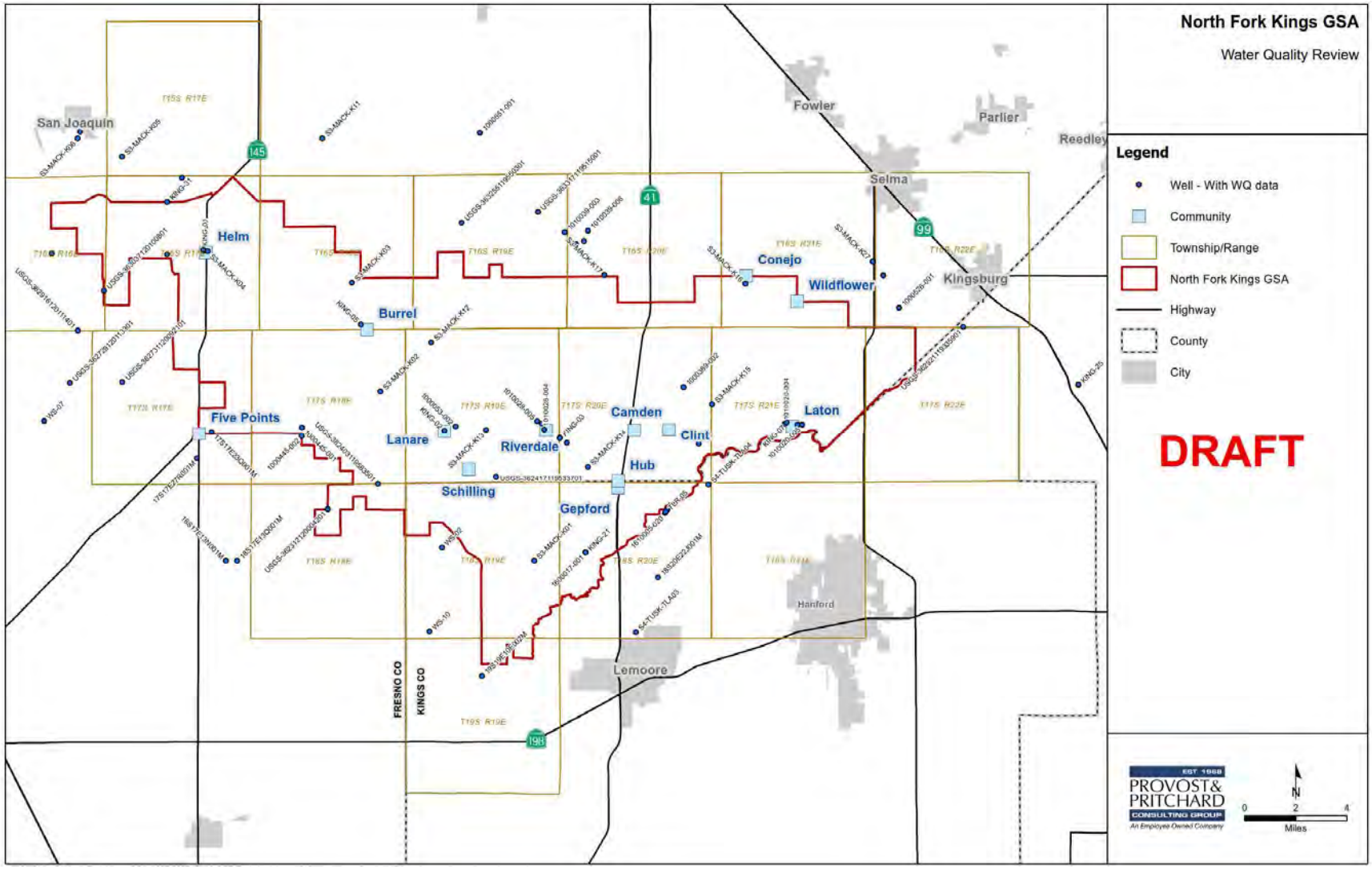
NFKGSA Water Quality

- Water Quality is one of the sustainability indicators that will be considered when setting minimum thresholds
- Water quality data was obtained from SWRCB Groundwater Ambient Monitoring and Assessment Program (GAMA) https://www.waterboards.ca.gov/gama/
- 73 wells contained in the water quality monitoring network


North Fork Kings GSA
Water Quality Review
Legend
Well - With WQ data
Community
Township/Range
North Fork Kings GSA
Highway
County
City
DRAFT
San Joaquin
Fowler
Parlier
Reedley
Selma
Kingsburg
Conejo
Wildflower
Helm
Burrel
Five Points
Lanare
Riverdale
Camden
Clint
Laton
Hub
Schilling
Gepford
Hanford
Lemoore
FRESNO CO
KINGS CO
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NFKGSA Water Quality

- Queries focused on identifying the highest recorded concentration for each constituent for the most recent 10-year period
- The data was queried and compared to established maximum contaminant levels (MCL), secondary MCLs, or health-based screen levels for constituents without an MCL.

NFKGSA Water Quality

- The following table lists constituents with exceedances

Primary MCL	Secondary MCL	Health-Based Screening Level
Arsenic	Aluminum	Boron
Chromium	Iron	Molybdenum
1,2-Dibromo-3-chloropropane	Manganese	
Ethylene Dibromide	Total Dissolved Solids	
Fluoride		
Gross Alpha		
Lead		
Nitrate		
Selenium		
1,2,3-Trichloropropane		
Total Trihalomethane		

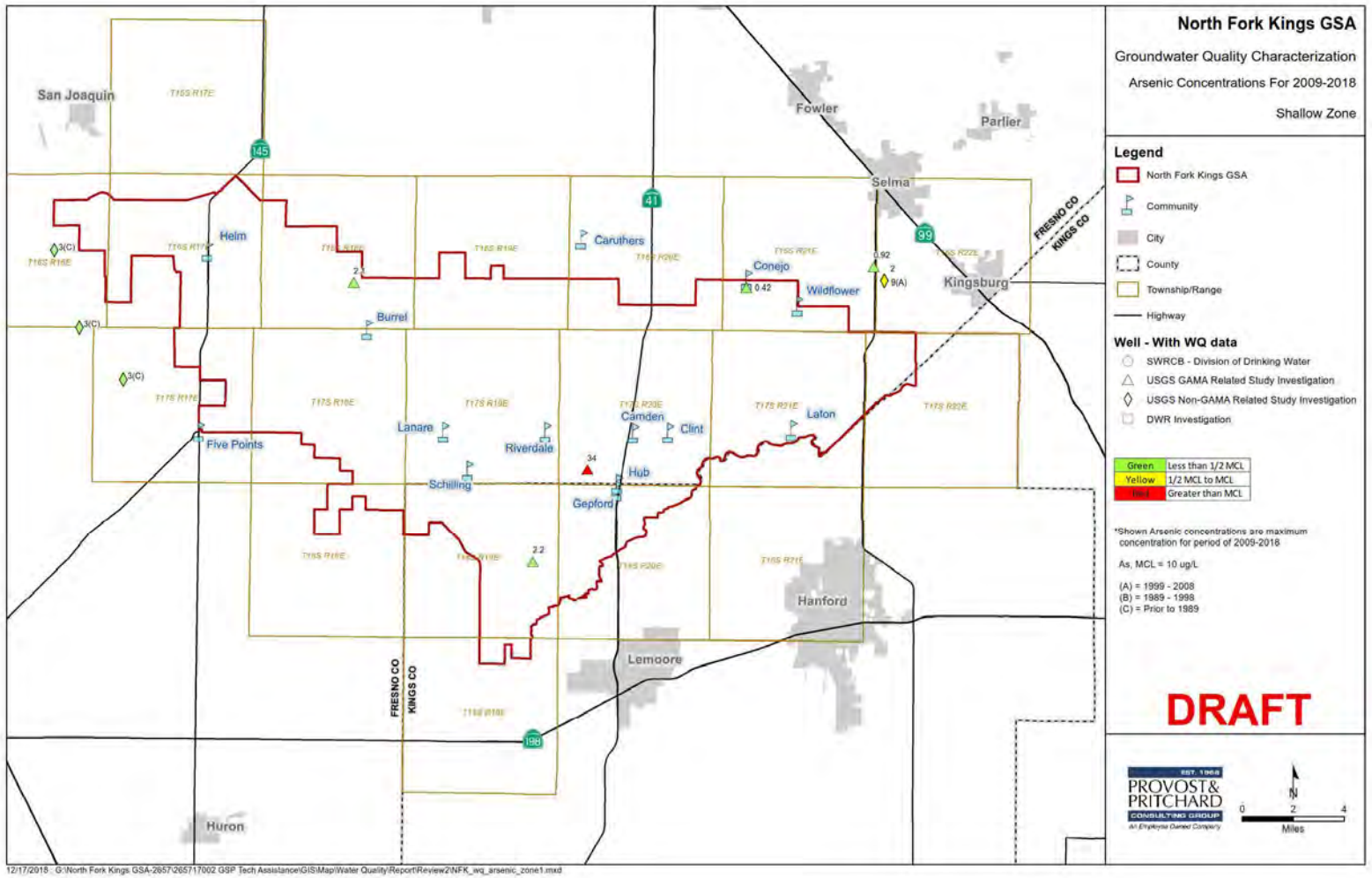
NFKGSA Water Quality

- Wells were assigned to conceptual aquifer zones
  - Shallow zone = 0 to 150 feet below ground surface (bgs)
  - Intermediate zone = 150’ bgs to base of unconfined aquifer (E-clay)
  - Deep zone = below unconfined aquifer (E-clay)
- Geologic cross sections were developed along Mt. Whitney Avenue to display all zones and maximum values.

NFKGSA Water Quality

- The following table shows zones of exceedances

	Shallow	Intermediate	Deep
Arsenic		X	X
DBCP			
Gross Alpha		X	
Manganese		X	
Total Dissolved Solids	X	X	X
1,2,3-Trichloropropane	X		
Uranium		X	
Molybdenum	X		
Lead		X	X
Selenium			
Nitrate	X	X	X
Iron	X	X	X
Fluoride		X	X



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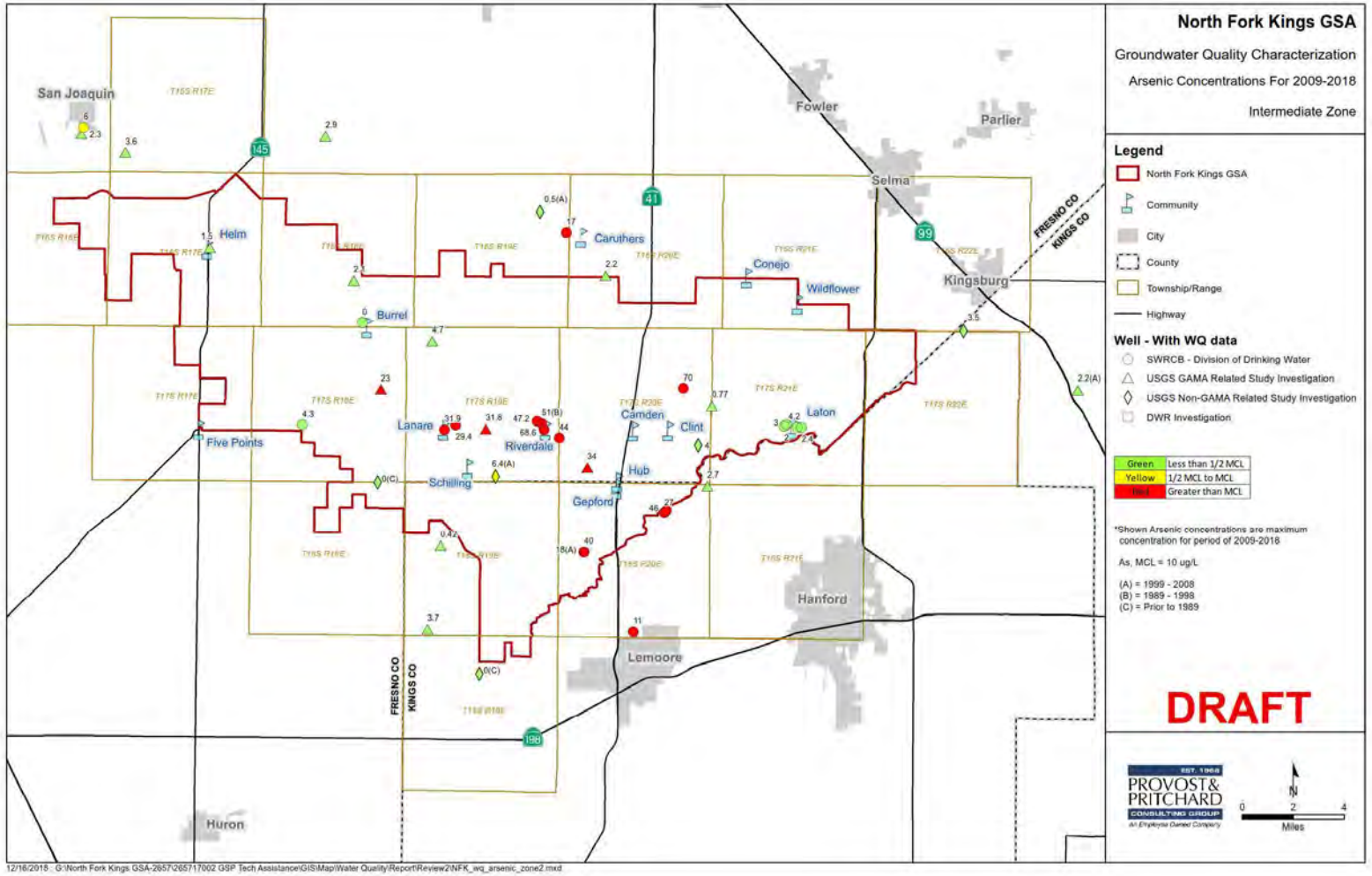

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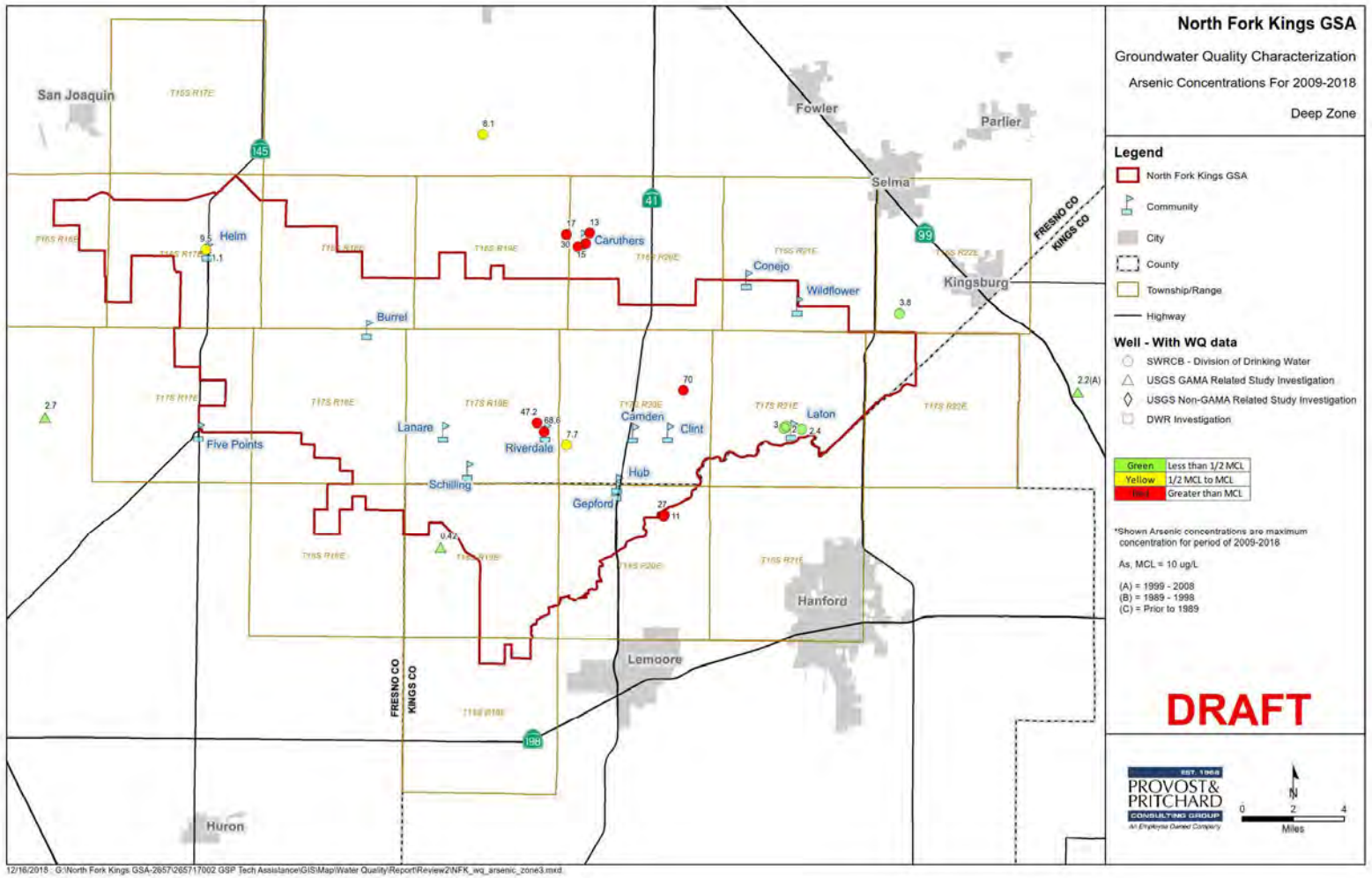

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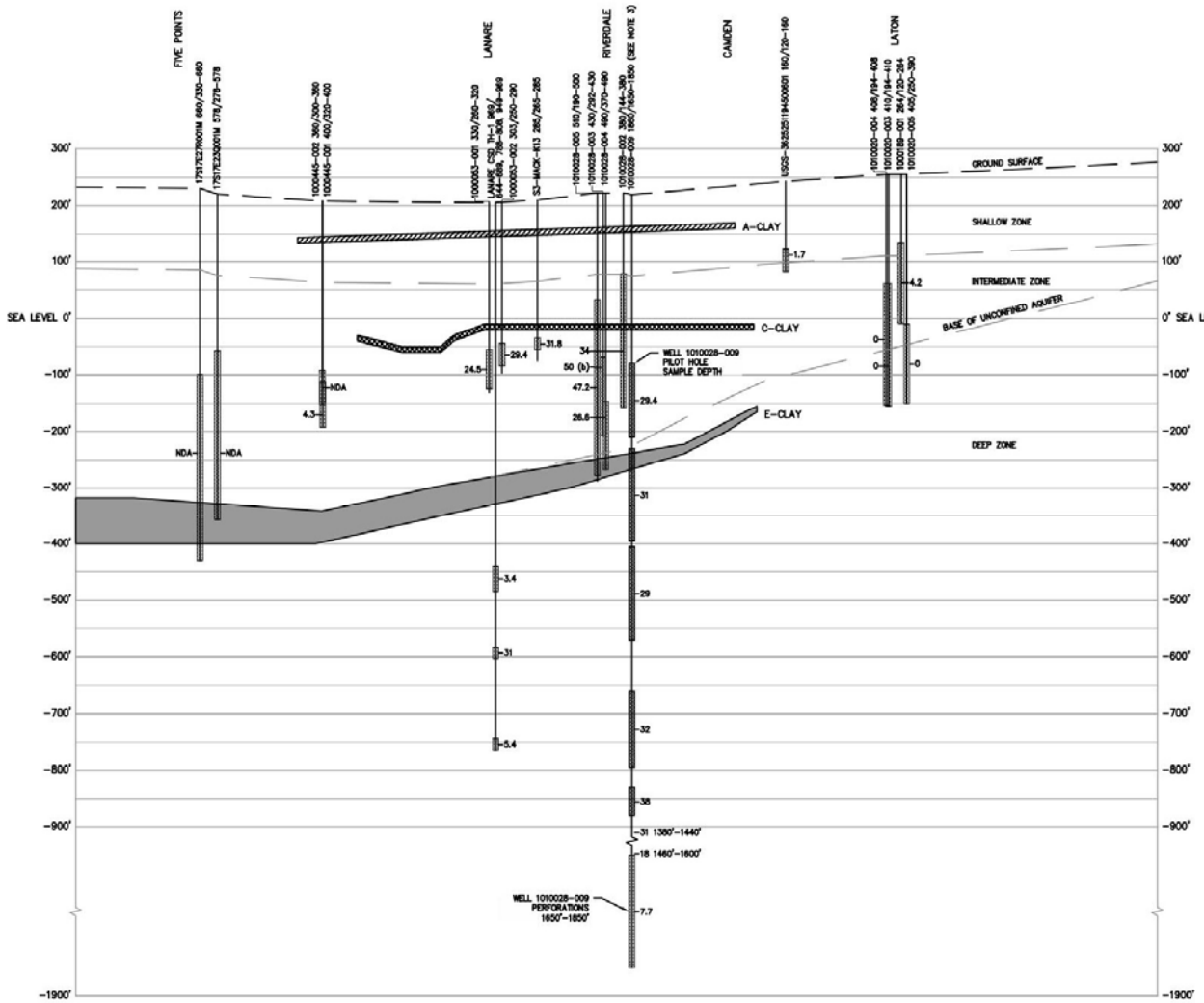


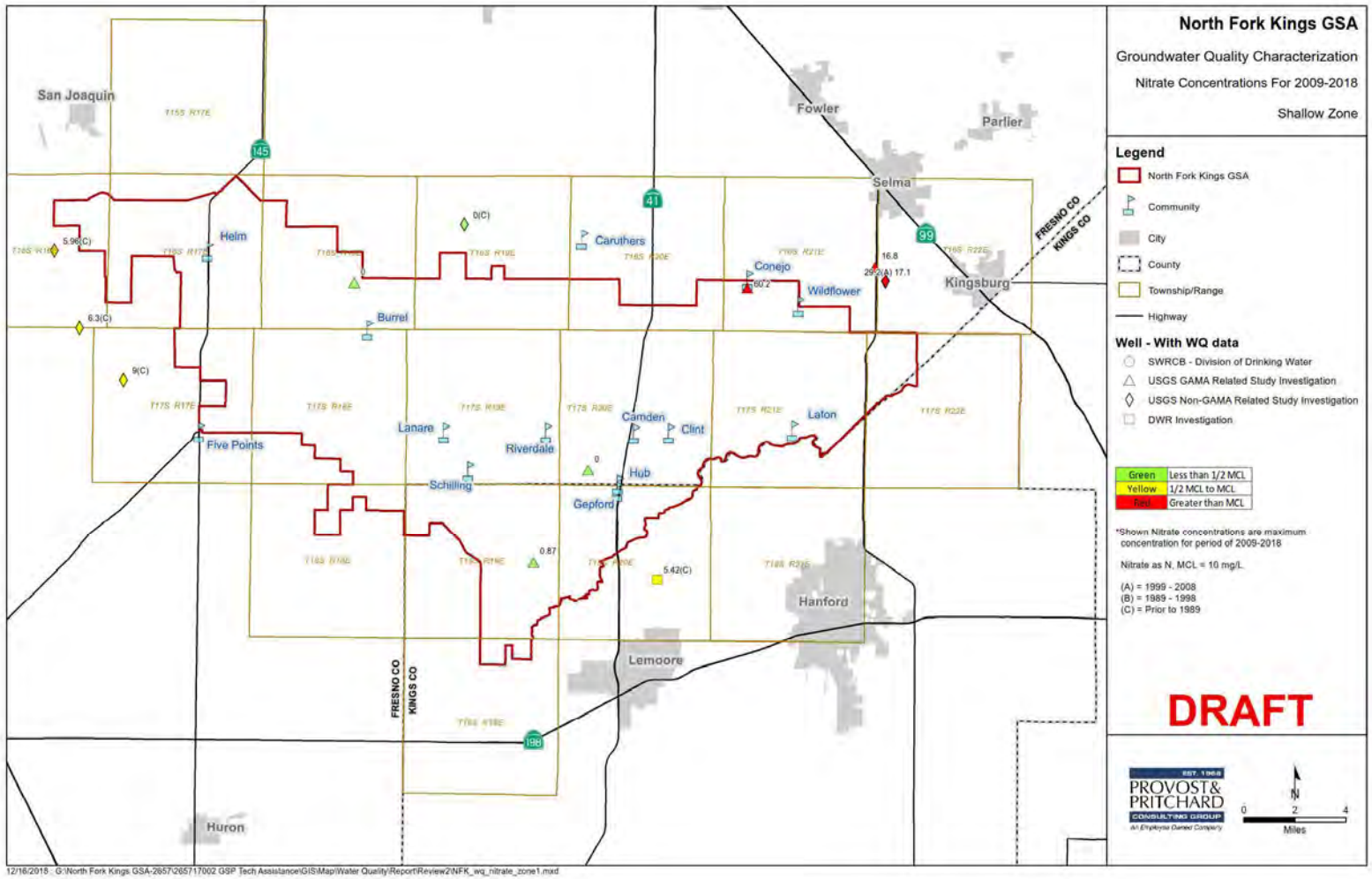
LEGEND

- WELL AND PERFORATIONS
- 4.3 ARSENIC CONCENTRATION (µg/L)
- NDA NO DATA AVAILABLE
- a SAMPLE DATE 1999–2008
- b SAMPLE DATE 1989–1998
- c SAMPLE DATE PRIOR TO 1989

NOTES:

1. CLAY LAYERS BASED ON PLATES IN USGS WATER SUPPLY PAPER 1999–H, CROFT, 1972.
2. BASE OF UNCONFINED AQUIFER BASED ON TECHNICAL MEMORANDUM 1, FIGURE 1, SCHMIDT, 2018.
3. PILOT HOLE FOR WELL 1010028–009 SAMPLE DEPTHS ARE:
   300–430; 450–615
   625–790; 880–1015
   1050–1110; 1380–1440
   1460–1600; 1630–1825
4. SHOWN ARSENIC CONCENTRATIONS ARE MAXIMUM CONCENTRATION FOR PERIOD OF 2009–2018.

Arsenic, MCL = 10 µg/L



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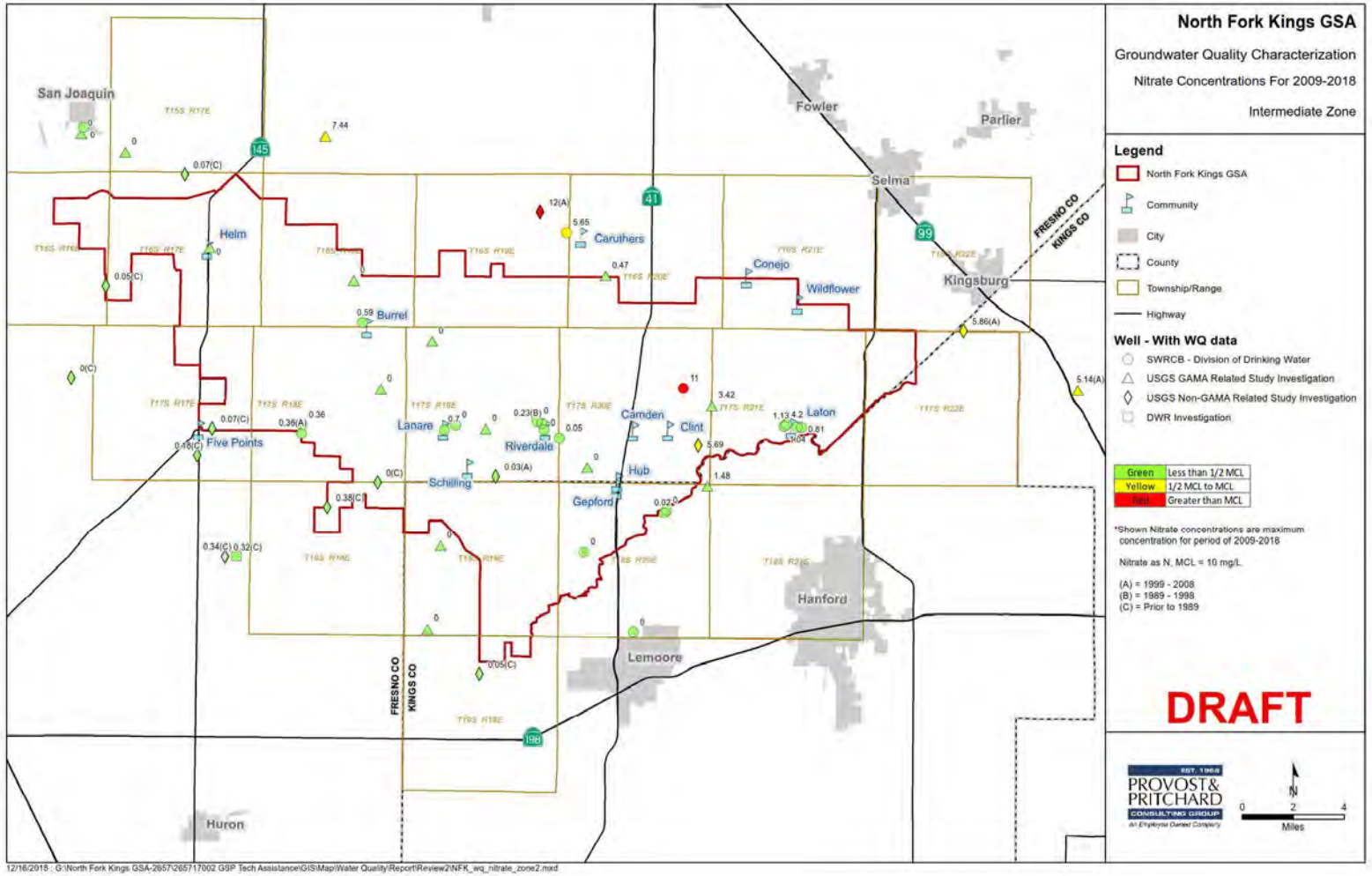

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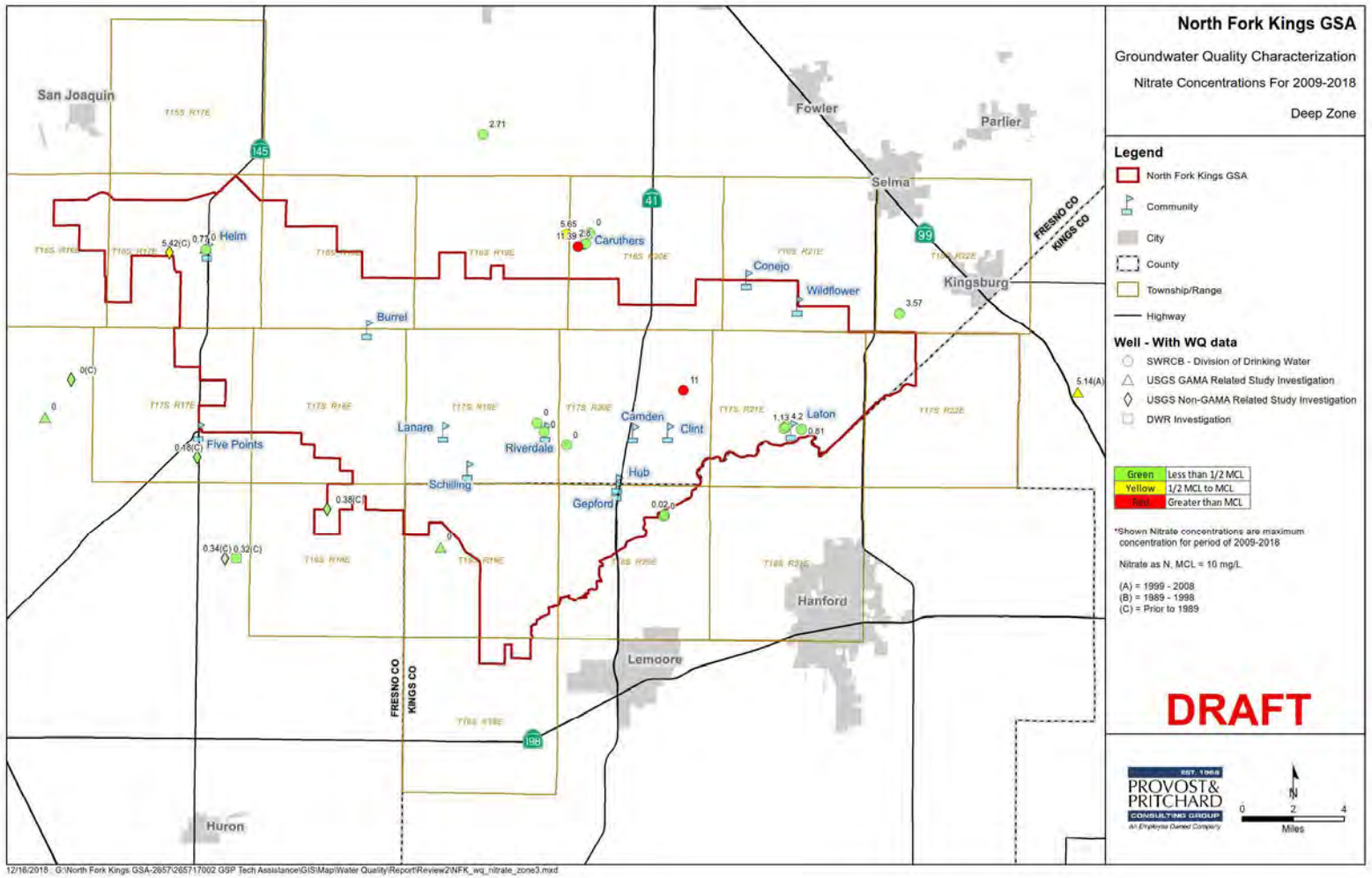

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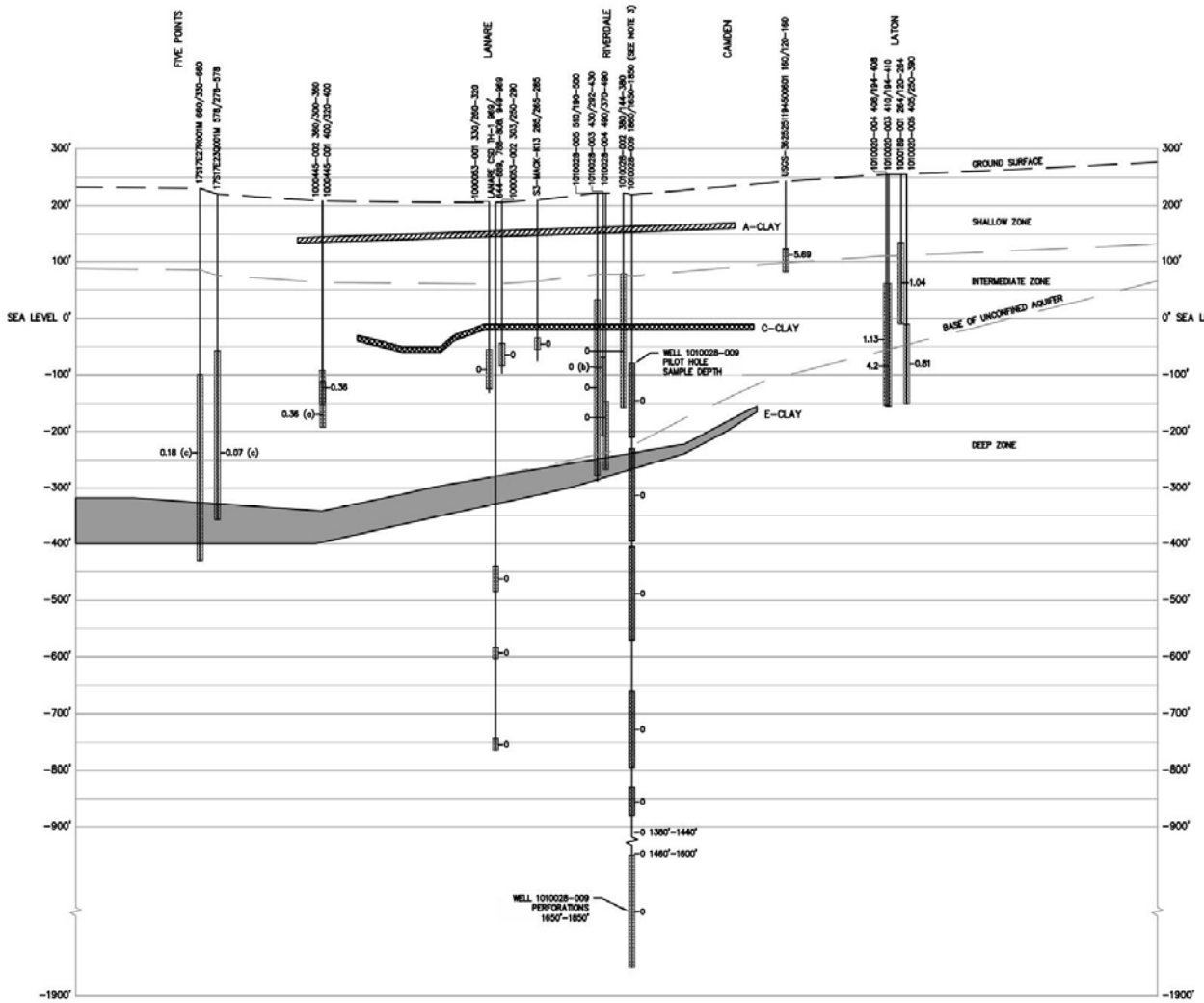

LEGEND

- WELL AND PERFORATIONS
- 4.3 NITRATE (as N) CONCENTRATION (mg/L)
- NDA NO DATA AVAILABLE
- a SAMPLE DATE 1999–2008
- b SAMPLE DATE 1989–1998
- c SAMPLE DATE PRIOR TO 1989

NOTES:

1. CLAY LAYERS BASED ON PLATES IN USGS WATER SUPPLY PAPER 1999-H, CROFT, 1972.
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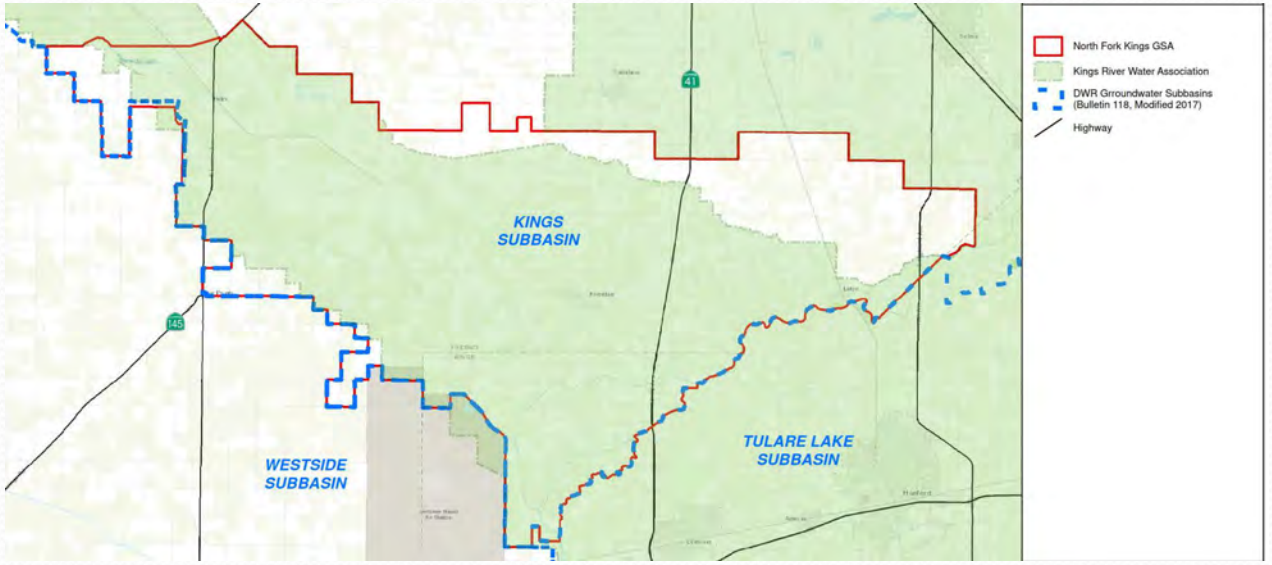
   300–430; 450–615
   625–790; 880–1015
   1050–1110; 1380–1440
   1460–1600; 1630–1825
4. SHOWN NITRATE CONCENTRATIONS ARE MAXIMUM CONCENTRATION FOR PERIOD OF 2009–2018.

Nitrate as N, MCL = 10 mg/L

Water Budget

- Water budget is required to be prepared as part of GSP
- Water demand not met by surface water or precipitation is met by groundwater pumping
- Surface water supply within NFKGSA almost exclusively Kings River
- Approximately 22% of NFKGSA area is outside Kings River service area



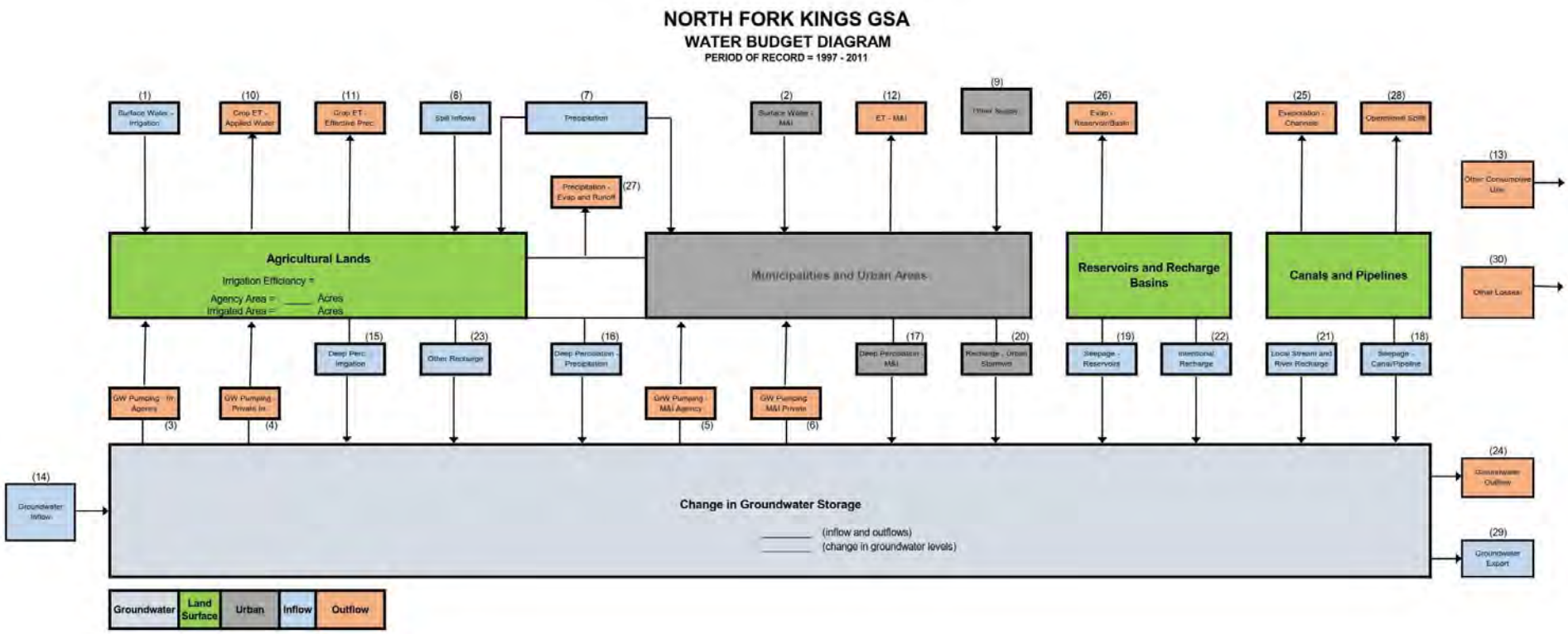
Water Budget Components

- Summarize all water sources and uses
  - Sources: Surface water, precipitation, groundwater (estimate)
  - Uses: Irrigation, municipal, residential, industrial
- Summarize hydrological interactions
  - Land Surface: Groundwater interactions
    - Groundwater pumping, deep percolation, intentional recharge, river/canal seepage
  - Land Surface: Atmosphere Interactions
    - Precipitation, evaporation, crop evapotranspiration
- Calculate change in groundwater storage
  - Water into groundwater system minus Water out of groundwater system
- Future simulations required to estimate impact on groundwater

Water Budget Components

Description
Supply
1) Surface Water for Irrigation and Recharge
2) Surface Water for M&I and Recharge
3) Groundwater Pumping for Irrigation (Agency Wells)
4) Groundwater Pumping for Irrigation (Private Wells, unknown)
5) Groundwater Pumping for M&I (Agency Wells)
6) Groundwater Pumping for M&I (Private Wells)
7) Precipitation
8) Spill Inflows
9) Other Supply
Demand
Consumptive Use
10) Evapotranspiration met by Applied Water
11) Evapotranspiration met by Effective Precipitation
12) Evapotranspiration of M&I
13) Other Consumptive Use

Description
Groundwater Recharge
14) Groundwater Inflow
15) Deep Percolation of Irrigation Water
16) Deep Percolation of Precipitation
17) Deep Percolation of M&I Water
18) Seepage of Channels & Pipelines
19) Seepage - Reservoirs
20) Urban Stormwater - Recharge
21) Local Streams/Rivers - Recharge
22) Groundwater - Intentional Recharge
23) Other Recharge
Nonrecoverable Losses
24) Groundwater - Outflow
25) Evaporation - Channels
26) Evaporation - Reservoirs & Recharge Basins
27) Precipitation - Evaporation and Runoff
28) Operational Spills
29) Groundwater - Export
30) Other Losses


NORTH FORK KINGS GSA
WATER BUDGET DIAGRAM
PERIOD OF RECORD = 1997 - 2011
(1)
Surface Water - Irrigation
(10)
Crop ET - Applied Water
(11)
Crop ET - Effective Prec.
(8)
Spill Inflows
(7)
Precipitation
(2)
Surface Water - M&I
(12)
ET - M&I
(9)
Other Supply
(26)
Evap - Reservoir/Basin
(25)
Evaporation - Channels
(28)
Overstream Spills
(13)
Other Consumptive Use
(27)
Precipitation - Evap and Runoff
Agricultural Lands
Irrigation Efficiency =
Agency Area = _____ Acres
Irrigated Area = _____ Acres
Municipalities and Urban Areas
Reservoirs and Recharge Basins
Canals and Pipelines
(30)
Other Losses
(15)
Deep Perc - Irrigation
(23)
Other Recharge
(16)
Deep Percolation - Precipitation
(17)
Deep Percolation - M&I
(20)
Recharge - Urban Stormwa
(19)
Seepage - Reservoirs
(22)
Intentional Recharge
(21)
Local Stream and River Recharge
(18)
Seepage - Canal/Pipeline
GW Pumping - Irr. Agency
(3)
GW Pumping - Private Irr.
(4)
GW Pumping - M&I Agency
(5)
GW Pumping - M&I Private
(6)
(14)
Groundwater Inflow
Change in Groundwater Storage
_____ (inflow and outflows)
_____ (change in groundwater levels)
(24)
Groundwater Outflow
(29)
Groundwater Export
Groundwater
Land Surface
Urban
Inflow
Outflow

Questions?