OGDEN RIVER 9-ELEMENT WATERSHED PLAN

PREPARED FOR THE WEBER RIVER PARTNERSHIP

November 20, 2023

Socio-Ecological Concepts LLC dba Redfish Environmental

This report is available in alternative formats upon request, and online at **www.eRedfish.com**

Author

Ernesto de la Hoz

Contributors/acknowledgements

Catherine James, representing the Weber River Partnership (WRP) played a crucial role in coordinating efforts with state, local entities, and landowners for the Ogden River Watershed project. Redfish Environmental LLC (RedFISH) served as the primary consultant for the WRP, taking responsibility for project implementation and deliverables. The Utah Division of Water Quality (UDWQ) played a key role with technical elements of this project. Christine Osborne, in particular, contributed by providing current water quality data, facilitating the acquisition of data for assessing pollution from onsite wastewater treatment systems, and actively participating in technical review meetings. Andrea Taillacq (Tailwater Limited) and Daniela Harris (RedFISH) undertook the task of compiling and summarizing available data for watershed characterization and pollutant load calculations.

Throughout the project, key partners engaged in conference calls to address challenges and issues. Public and stakeholder meetings were conducted to identify non-point source pollution concerns and areas of interest. These gatherings also aimed to identify potential measures and projects, laying the groundwork for subsequent funding requests that could yield practical benefits for the Ogden River Watershed. A conclusive public meeting was convened to present the watershed plan, and feedback from Advisory Committee and the public was incorporated to refine strategies and align them with the goals of the watershed plan.

This collaborative effort involved the contributions of many individuals. Lucy Jordan (Utah Geological Survey) and James McBride (Weber County) provided residential parcel data required for analyzing pollution from onsite wastewater treatment systems. Maya Pendleton (Ogden Nature Center) formulated recommendations for information and education activities. Christine Osborne (UDWQ), Emily Bishop (Utah Department of Agriculture and Food), Melissa Early (Utah Division of Wildlife Resources), and Tanner Cox (Trout Unlimited) reviewed a draft of the watershed plan. The funding for the Ogden River Watershed Plan was provided by the UDWQ.

Contents

List of Tables

List of Figures

Executive summary

This plan was developed to fulfill the requirements set forth by the U.S. Environmental Protection Agency (EPA) for recipients of grants appropriated by Congress under Section 319 of the Clean Water Act (EPA 2013). The requirements highlight the use of watershed-based plans that contain the nine minimum elements documented in the guidelines and EPA's Handbook for Developing Watershed Plans to Restore and Protect our Waters (EPA 2008). This nine element plan (9E Plan) will look into specific and targeted actions to achieve water quality goals in the Ogden River Watershed. The nine elements are listed in Table 1 along with the section of this report in which each nine element can be found. The recommended measures in Section 7 aim to bring waterbodies in line with water quality standards.

The 9E Plan incorporates quantitative approaches to identify pollutant sources, define measurable targets, and identify control measures. Analysis of water quality data and the Pollutant Load Calculator Tool (PLET model) were used to characterize the Ogden River Watershed and estimate sources and geographical areas that contribute nitrogen, phosphorus and sediment from the landscape. This model provides a tool to evaluate pollutant loads by subwatershed and by source; it is also a tool to identify priority areas for implementing pollution reduction measures given underlying conditions of environmental setting, land cover, land use, and management practices. Additionally, a watershed-scale model for soil erosion potential was created to aid in subsequent efforts to refine targets and prioritize areas for implementing Best Management Practices (BMPs).

According to the PLET model, approximately 50% of the nitrogen load in the Ogden River Watershed is attributed to the Middle Fork Ogden River (27%) and the North Fork Ogden River (21%). Substantial nitrogen loads were also observed in the South Branch South Fork Ogden River (16%) and Mill Creek (19%). The Middle and North Forks of the Ogden River significantly contribute to the phosphorus and sediment loads in the watershed.

Pollutant load assessments by source revealed that urban land use contributes 32% of the nitrogen load in the Ogden River Watershed, while cultivated and pasture lands contribute 22% and 14%, respectively. Onsite septic systems, account for 11% of the nitrogen load across the watershed. This is a considerable source of nitrogen given that onsite septic systems are primarily found in the Ogden Valley.

The plan proposes target areas and priorities for restoration based on beneficial use impairments, relative contribution of pollutant loads, and areas having elevated nutrient enrichment levels. The plan implementation strategy was developed according to the priority ranking to address the water quality goals and pollutant reduction targets.

The benefits and costs of measures and practices to reduce pollutant inputs must be balanced across multiple subwatershed and sources. An important component of all the recommendations is to increase public outreach and educations and identify and acquire funding and technical support for implementation of recommended measures and practices. Implementing the 9E Plan's recommendations will require continued collaboration among the many partners engaged

with Pineview Reservoir and watershed management issues. Progress will be tracked and reported through continued data collection and evaluation, updating the watershed modeling tools, institutional collaboration, and communication among all stakeholders.

An ongoing commitment to adaptive management, involving setting targets, implementing recommendations, monitoring their impact, and adjusting to new conditions, is an essential component of the 9E Plan. This 9E Plan for nitrogen, phosphorus and sediment reductions is based on current conditions of land cover, animal numbers, management practices, and population. Continued data acquisition and model refinements will enable the 9E Plan to reflect new information and continue to serve as a resource for informed management decisions. Adjustments will be made as needed to continue progressing towards meeting water quality standards.

[Remainder of Page Left Blank]

1. Introduction

1.1. Document overview

This document is intended to address the nine elements, identified in EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters* (USEPA, 2008), that EPA considers fundamental to preparing effective watershed plans to address nonpoint source pollution. EPA emphasizes the use of watershed-based plans containing the nine elements in Section 319 watershed projects in its guidelines for the Clean Water Act Section 319 program and grants (USEPA, 2013).

This plan is based on the data collection, analysis, and development of plans from multiple sources and scales. Most of the monitoring and planning efforts conducted by the State of Utah Division of Water Quality (assessments, TMDLs, etc.) are conducted and reported on through delineated assessment units (AUs). These efforts provide the support to develop targeted workplans for small watersheds. This watershed plan will address specific and targeted actions to achieve water quality goals at a larger, watershed level scale.

This document is intended to be a living document. Building upon existing data and previous work, through the initial development of this watershed plan effort, early stages of plan implementation, and further monitoring and data collection, this plan is a road map intended to protect, change, respond, and improve watershed conditions in the Ogden River Watershed.

The overarching goal of the nine-element watershed planning guidelines is to provide direction in developing a comprehensive plan at an appropriate scale so that problems and solutions are targeted effectively. The nine elements are listed in Table 1 along with the section of this document in which each of the nine elements can be found.

The implementation measures intended to maintain or improve waterbodies to meet water quality standards, will be described in Section 7 of this plan. Following the identification of these measures, this plan is intended as an adaptive management approach to evaluate best management practice (BMP) effectiveness and proposed implementation timelines. Identification of specific critical areas, potential project locations, and necessary adjustments will be made to continue the progress towards achieving water quality standards.

1.2. Planning purpose and project organization

The purpose of this plan is to build upon existing work that has been completed in the Ogden River Watershed.

The comprehensive goal of this project is three-fold:

1) Synthesize existing data to characterize the watershed,

2) identify issues and areas of concern and identify watershed goals and objectives with input from stakeholders and guidance from existing data,

3) and provide a comprehensive watershed plan with recommendations and a list of potential projects and strategies to help meet watershed goals, objectives, and water quality standards for water bodies in the project area.

TABLE 1. NINE ELEMENTS AND REPORT SECTION

Summary of Section 319 Nine Elements to be included in watershed plan	Applicable Report Section
a. Identification of causes and sources of pollution.	Section 4: Quantitative tools to estimate pollutant loads and define priority action Section 5: Pollutant loading and sources of pollution
b. Estimation of pollutant loading, and load reductions expected from management measures.	Section 6.2: Pollutant reduction targets
c. Description of the nonpoint source management measures that will need to be implemented to achieve load reductions in element b, and description of the critical areas in which those measures will be needed to implement this plan.	Section 6: Priority areas and restoration strategies
d. Estimate of the amounts of technical and financial assistance needed, and/or the sources and authorities that will be relied upon to implement this plan.	Section 7.4: Technical and financial assistance
e. Develop an information and education component used to enhance public understanding of the project and encourage the public's early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Section 1.3. Key partners. Section 3.1. Vision, goals, and targets. Section 7.3. Information and education activities
f. Develop schedule for implementing the nonpoint source management measures identified in this plan.	Section 7.2: Projects and load reductions
g. Describe of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Section 7: Implementation strategy and project overview
h. Identify a set of criteria that can be used to determine whether loading reductions are being achieved over time and if progress is being made toward attaining water quality standards.	Section 7: Implementation strategy and project overview
i. Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under Element h, above.	Section 8: Monitoring

The development of this plan follows a series of steps to compile and synthesize data, characterize existing conditions, quantify pollutant loads, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adopt selected actions. Efforts will be focused on various levels throughout the watershed in targeted areas. The process was intended to address watershed health in a holistic manner by assessing natural resources, water features, water use, watershed characteristics, water quality impairments, and potential causes of pollution, then identify management measures and prioritize restoration and protection strategies to achieve load reductions. Through this process, gaps in the existing planning efforts can be identified and addressed. Circumstances in the watershed will change over time. Population growth, land-use change, implementation of BMPs, climate change, and other factors will lead to changes in the needs of the watershed. The

milestones and monitoring of progress developed under this plan will help guide future actions throughout the implementation process.

The Weber River Partnership (WRP) was awarded a Nonpoint Source Program Grant by the Utah Division of Water Quality (DWQ) to complete the plan and is the lead entity responsible for coordination with DWQ, other state, regional, and local entities, and the consultant team. Socio-Ecological Concepts LLC dba Redfish Environmental (RedFISH) is the consultant to WRP responsible for project execution and deliverables. Under a memorandum of understanding (MOU) between Davis Conservation District (District) and WRP, the District acts as the fiscal agent for WRP. The DWQ team reviews and approves project deliverables and reimbursement requests and provides overall guidance to RedFISH to meet the contractual requirements of the DWQ grant award.

1.3. Key partners

Multiple agencies, organizations, and individuals have been active in one or more watershed management-related activities in the Ogden River Watershed. A list of key partners is provided in Table 2.

TABLE 2. KEY PARTNERS

Entity
Utah Division of Water Quality
Utah Department of Agriculture and Food
Utah Department of Natural Resources (or Utah Division of Wildlife Resources)
U.S. Forest Service
Weber Basin Water Conservancy District
Utah Geologic Survey
Weber-Morgan County Health Department
Ogden Nature Center
Trout Unlimited
Ogden Valley Landowners

The WRP is made up of individuals and organizations who are passionate about the Weber River Watershed. Members include representatives from Utah Division of Water Quality, Utah Department of Agriculture and Food, Weber Basin Water Conservancy District, Trout Unlimited, Utah Division of Wildlife Resources,, PacifiCorp, and Ogden Nature Center. Participation is expected to grow in the future as the partnership continues to coalesce.

1.4. Evolution of partnerships and plans

Although a watershed plan has not been previously prepared for the Ogden River, various studies have been conducted and water resources management strategies have been initiated. A Total

Maximum Daily Load (TMDL) study was completed for Pineview Reservoir (Tetra Tech 2002) given that the reservoir was placed on Utah's 2000 section 303(d) list for dissolved oxygen (DO), temperature, and total phosphorus (TP). These water quality impairments remain today with the addition of a pH impairment (see Section 2.2). The TMDL linked these impairments to a combination of several factors including nutrient loading from groundwater, on-site wastewater treatment systems, animal waste, and tributaries that flow into the reservoir. Additionally, there is the possibility of internal phosphorus loading from within the reservoir. The input of nutrients from tributaries is associated with various land use activities in the watershed, including agricultural, residential, and to a lesser extent, commercial practices. According to the TMDL, onsite wastewater treatment systems have the potential to be the primary source of nitrogen, while tributary loadings have the potential to be the main source of phosphorus load to Pineview Reservoir. The TMDL also noted that increased development in the valley could lead to increased nutrient loads from onsite wastewater treatment systems.

The TMDL focused on groundwater, onsite wastewater treatment systems, pollution from tributaries, animal waste, and reservoir internal nutrient loading, and its project implementation plan aimed at reducing phosphorus and nitrogen loads by improving irrigation systems, establishing a septic system improvement program, developing a sewer system for Ogden Valley, improving livestock and manure management practices, and reducing erosion potential through range treatments and buffer strips along streams (Tetra Tech 2002). In the years since the completion of the Pineview Reservoir TMDL, watershed-based non-point pollution efforts have been modest, and the completion of additional studies and plans can help target implementation actions.

The Weber River Watershed Plan was a collaboration-based plan developed in 2014 by stakeholders organized through the WRP. The plan was developed to address challenges to ecosystem health resulting from water quality impairments, limited water supply, population growth, increased development and water demand, historic and current stream habitat and water management, and limited stakeholder communication/collaboration due to a lack of watershed-scale leadership structure (WRP 2014). Strategies identified to address challenges included increased communication and collaboration among stakeholders to develop large-scale restoration, protection, and water conservation projects; development of a public outreach, communication, and education plan; enhancement of instream flows and water conservation practices; and aquatic and riparian habitat protection and improvement.

The 2018 Water Conservation Plan update for the Weber Basin Water Conservancy District (WBWCD, 2018) was prepared to meet requirements of the 1998 Utah Water Conservation Act. The focus of WBWCD conservation efforts is to reduce per capita water consumption through programs and education for indoor and outdoor water use efficiency. The plan highlighted population growth projections and future water demands, existing water supply, and water conservation initiatives to meet conservation goals. Programs and activities intended to reduce water demands include the adoption of the statewide goal 25% per capita reduction by 2025, changes in policies to prevent daytime outdoor watering, establishing a public information and education campaign (using the State's "Slow the Flow" campaign), public outreach, creation and distribution of printed material with conservation education information, member agency

meetings to coordinate, metering secondary water connections, and education on best landscape practices suitable for the local climate and soils. Future conservation programs include continued water management improvements, metering and accounting, education and media campaigns to promote wise use of water, particularly for outdoor use, and increased coordination with member agencies to address policy, programs, and education for residents (WBWCD, 2018).

Population growth, water resource development, and concerns about wastewater disposal led the Utah Geologic Survey (UGS) to the development of a water quality and quantity study of groundwater in the Ogden Valley (Jordan et al., 2019). This comprehensive hydrogeology study addressed the interactions between streams, canals, bedrock and valley-fill aquifers, and Pineview Reservoir. The septic-tank density analysis component of this study indicated that on-site septic systems have contributed to high nitrate concentrations in Ogden Valley aquifers and provided recommendations for septic system density thresholds to meet desired water-quality degradation limits.

Under the framework of the Weber River Watershed Plan, a proposal for the Weber River ecological resiliency project was prepared by Trout Unlimited in 2022. The goal of this project is to improve the ecological resilience within the Weber River Basin through improvement in drought resiliency and riparian health in arid mid-elevation tributaries using process-based restoration tools such as beaver dam analogs (BDAs), reconnecting key habitats on the Ogden River through irrigation diversion modernization and reconstructing important side channel habitats and restoring floodplain function. Among the elements identified in this project there is an irrigation diversion modernization project to reconnect fish habitat on the lower Ogden River, provide a reliable source of water for irrigation, and improve stream safety for recreation.

2. Watershed description

The first step to characterizing the Ogden Watershed was to gather and compile the available water-quality information from DWQ and other agencies/stakeholders, land use trends from National Land Cover Database (NLCD), and flow data from USGS. The available data including length of record, quality, and frequency was summarized to determine the appropriate approach for watershed characterization. The methods used to summarize existing data and characterize the watershed are described below.

2.1. Water quality

Water quality dataset overview

Data from Weber County were downloaded from the EPA Water Quality Portal (WQP) using the USGS R data retrieval package. Monitoring sites within the project area were mapped using the WQP supplied latitude and longitude and spatially joined to the HUC 12 shapefile. All available data for each HUC 12 was summarized to develop a data inventory. Water quality data was reviewed to determine quantity and period of available data. This dataset is provided as a separate spreadsheet (WQPDataInventory.xlsx.)

Monitoring sites identified within the study area are associated with a variety of sampling programs including the Utah Division of Water Quality, Utah Geological Survey, UGS Utah Water Science Center, and various EPA programs. Each of these sites were analyzed to determine if the site had associated data. Each monitoring program samples water characteristics using methods and at frequencies defined by the respective program objective. A list of sites by HUC 12 with a monitoring location identifier is provided in a separate Excel worksheet (SampleSitesStreamflow.xls). This worksheet documents whether the site has associated data and if there is a streamflow gage that could be used to provide flow data. A summary table within this worksheet includes the number of samples collected from 2012 to 2022 for each of the nutrient characteristics. Only River/Stream sites with nutrient data from 2012–2022 were included in this analysis. Monitoring sites included in the analysis are listed in Table 3 and shown on Figure 1. Each site was given a short name for plot labels.

TABLE 3. MONITORING SITES WITH DATA INCLUDED IN ANALYSIS AND SHORT NAMES USED FOR GRAPHS

Site Identifier	Long Name	Short Name
Ogden River		
UTAHDWQ_WQX-4923010	OGDEN R AB CNFL / WEBER R	Ogden Confluence
UTAHDWQ_WQX-4923177	OGDEN RIVER AT WALL AVENUE CROSSING	Ogden Wall Ave
UTAHDWQ_WQX-4923200	OGDEN R AT MOUTH OF CANYON AT VALLEY DRIVE XING	Ogden at Canyon Mouth
UTAHDWQ_WQX-4923205	OGDEN R AT MOUTH OF CANYON AT VALLEY DRIVE XING REPLICATE OF 4923200	Ogden at Canyon Mouth Rep
Wheeler Creek		
UTAHDWQ_WQX-4924590	WHEELER CK AB CNFL / OGDEN R	Wheeler abv Ogden
North Fork Ogden		
UTAHDWQ_WQX-4924650	N FK OGDEN R AT U162 XING	NF Ogden Lower
Middle Fork Ogden		
UTAHDWQ_WQX-4924660	MIDDLE FK OGDEN R U166 XING	MF Ogden
South Fork Ogden		
UTAHDWQ_WQX-4924670	S FK OGDEN R SOUTH LEG BL U166 XING	SF Ogden

An inventory of streamflow monitoring sites was developed to evaluate the potential for completing load calculations. Of the 14 streamflow monitoring sites identified within the project area, only two had contemporary data: 10140100 Ogden River below Pineview Reservoir near Huntsville, UT and 10140700 Ogden River near Gibson Avenue at Ogden, UT (Table 4). No streamflow data was identified above Pineview Reservoir.

Water quality characteristics were inventoried using the USEPA TADA R library. This library automatically cleans the downloaded data for common naming convention issues. In addition to the standard cleaning routines, data specific clean-up was used to harmonize the dataset to remove retired characteristic names and standardize result sample fractions.

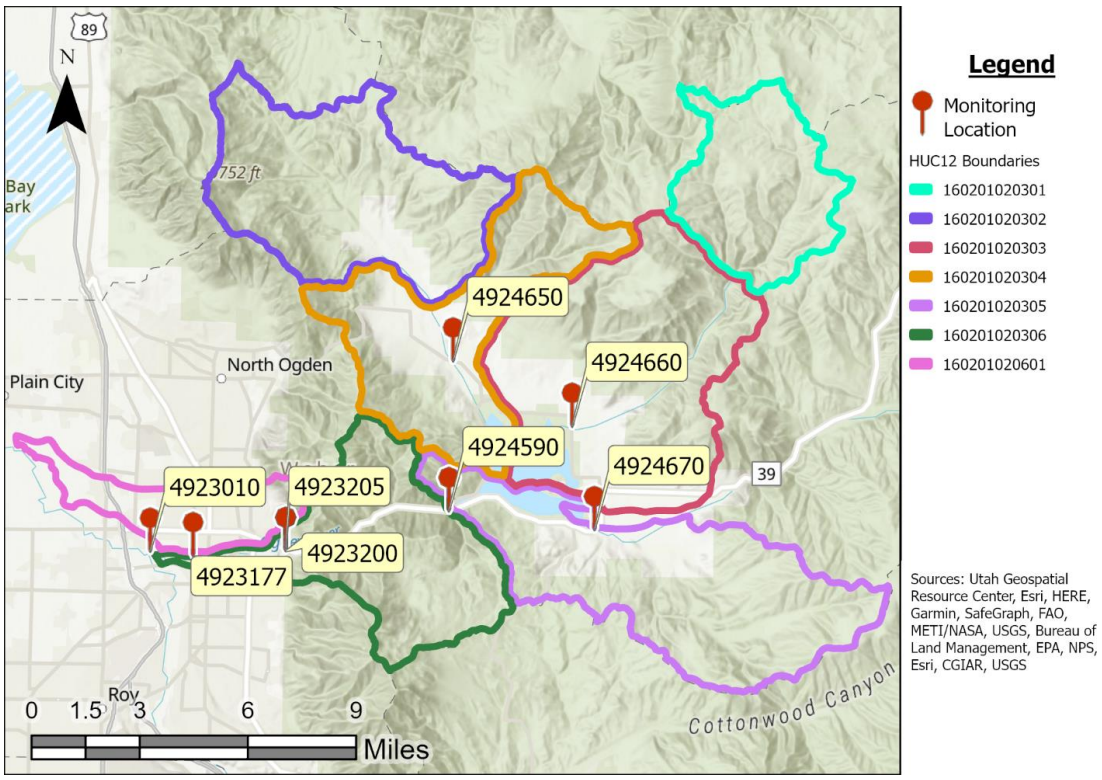


FIGURE 1. MONITORING SITE LOCATIONS WITHIN THE STUDY AREA WITH HUC12 OUTLINES

TABLE 4. STREAM FLOW MONITORING STATIONS WITH CONTEMPORARY DATA WITHIN THE STUDY AREA

Site Number	Station Name	Latitude in decimal degrees	Longitude in decimal degrees	HUC 12	Period of Record Start	Period of Record End
10140100	OGDEN RIVER BL PINEVIEW RES NR HUNTSVILLE, UT	41.25439	-111.85577	160201020306	10/1/1988	Present
10140700	OGDEN RIVER NR GIBSON AVENUE AT OGDEN, UT	41.23182	-111.98450	160201020306	4/12/2012	Present

Nutrient criteria

The Utah Headwater Streams report (UDWQ, 2019) guided the development of Numeric Nutrient Criteria (NNC) by evaluating baseline datasets for headwater streams within Utah. Accordingly, criteria used for evaluating analytical results to make determinations of impairment were guided by State regulations in Utah Administrative Code R317-2-14.

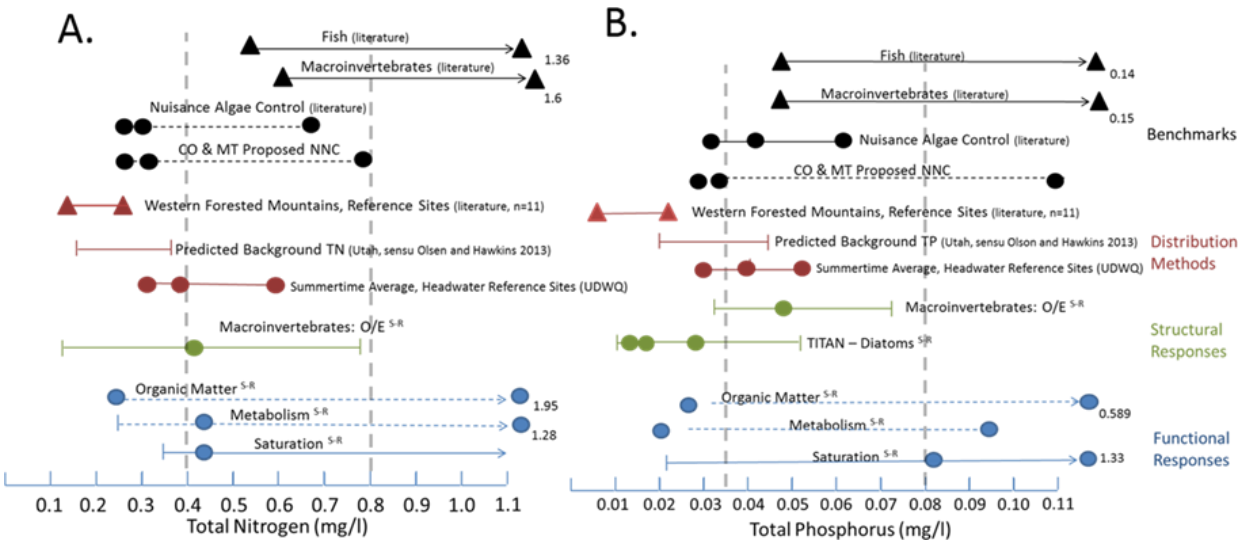


FIGURE 2. NUMERIC NUTRIENT CRITERIA THRESHOLDS DERIVED FROM NUMEROUS SOURCES FOR TOTAL NITROGEN (PANEL A) AND TOTAL PHOSPHORUS (PANEL B), ALONG WITH THE NUMERIC NUTRIENT CRITERIA FOR THESE NUTRIENTS. (FIGURE COPIED FROM DIVISION OF WATER QUALITY, 2019)

Notes: The vertical dotted lines are the numeric nutrient criteria thresholds. Lines bracketed by triangles indicate the omission of numerous intermediate thresholds (dots). The graphics are colored to demarcate different categories of thresholds. Blue denotes functional responses. Green denotes structural responses (DWQ calculations). Red denotes thresholds derived using frequency distribution methods: the bottom red dots indicate the 75th, 90th, and 95th percentiles of the summertime average of Utah reference sites; the middle red line denotes background concentrations obtained from an empirical model that predicts background concentrations from natural environmental gradients; and the top red line denotes other distribution methods from reference site distributions in USEPA Nutrient Ecoregion II (Evans-White et al. 2014). Black denotes broad benchmarks for other proposed numeric criteria from USEPA Region 8 (the bottom black line) and values obtained from primary literature (the top three black lines; Evans-White et al. 2014).

The numeric nutrient criteria were developed using three threshold levels. The threshold levels are listed in Table 5. Note that the TADA R package converts the units from mg/L to ug/L for the data processing so these units will be adjusted to ug/L. This conversion allows comparison of whole numbers.

TABLE 5. PROPOSED NUMERIC NUTRIENT CRITERIA. ALL CONCENTRATIONS ARE BASED ON ≧ 4 SAMPLES DURING THE PERIOD OF ALGAE GROWTH THROUGH SENESCENCE.

Level	Level 1: Low Enrichment	Level 2: Moderately Enriched	Level 3: Highly Enriched
Determination	Supporting aquatic life uses	Require documentation of no deleterious ecological responses before determining if aquatic life is supported	Not supporting aquatic life uses.
Total Nitrogen (as N) concentration in mg/L	<0.40 mg/L (<400ug/L)	0.40 mg/L – 0.80 mg/L (400ug/L-800ug/L)	>0.80 mg/L (>800ug/L)
Total Phosphorus (as P) concentration in mg/L	<0.035 mg/L (<35ug/L)	0.035 – 0.080 mg/L (350ug/L-800ug/L)	>0.080 mg/L (>800ug/L)

Statistics

A summary of all the nutrient characteristic data by site and censoring proportion was generated and is provided in a separate Excel file (studyAreaSampleStats.xlsx). A summary of the data used for this assessment is provided in APPENDIX I. Boxplots were generated for all site and characteristic combinations that had more than two samples and less than 80 percent censored data (i.e., values reported below the limit of detection, LOD). Site-by-site comparisons by characteristic were generated for sites with more than three samples and less than 50 percent censored values; 50 percent was selected as suggested by Helsel, 2012. The cenros Nondetects and Data Analysis package (NADA; Lee, 2020) was used to compute statistics when higher percentages of censored data were present and sample sizes were low.

Nitrogen

Numeric nutrient criteria are developed for total nitrogen. Total nitrogen is the measurement of all forms of nitrogen in the water sample including both organic and inorganic forms. The water quality sample data was compared to the numeric nutrient criteria as listed in Table 5. Boxplots for total nitrogen are provided in Figure 3. Boxplots for other nitrogen characteristics are included in APPENDIX II to provide supporting data. Results indicated that sites at North Fork Ogden River Lower and South Fork Ogden River presented high and moderate total nitrogen enrichment, respectively. Low total nitrogen enrichment was observed at other project area sites (Table 6). Here it should be noted that given the location of the water quality monitoring site (UTAHDWQ_WQX-4924660) in the Middle Fork Ogden River (HUC 160201020303), it is likely that not all inflows (and pollutant concentrations) are captured by this station and there are unaccounted pollutant concentrations that flow directly to Pineview Reservoir (Figure 1).

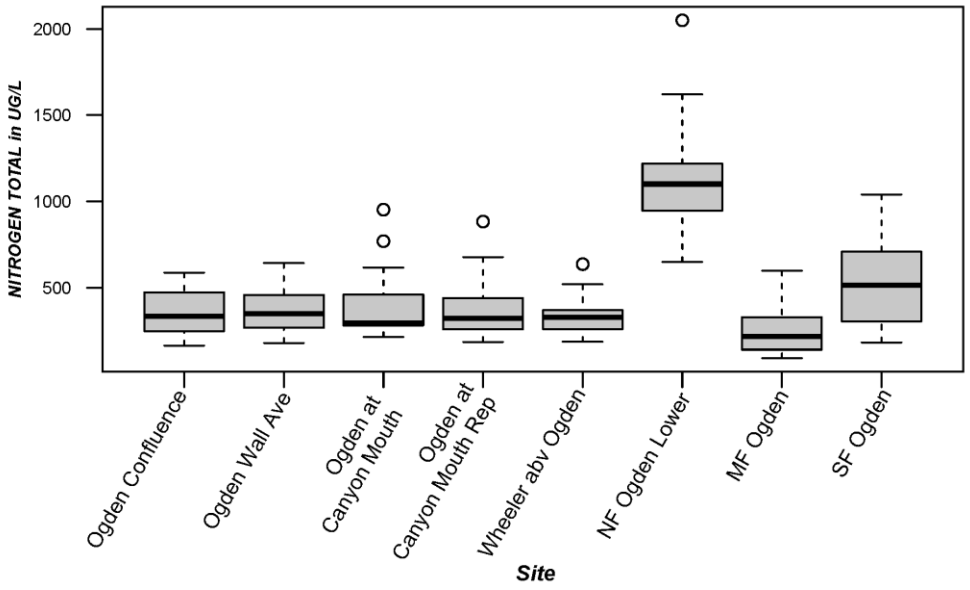


FIGURE 3. NITROGEN TOTAL BOXPLOTS FOR ALL YEARS (NO CENSORED DATA WAS PRESENT)

TABLE 6. SUMMARY OF NITROGEN ENRICHMENT LEVEL AT ALL SITES. NUTRIENT CATEGORIES FOR SAMPLE SITES WITH GREATER THAN 4 SAMPLES BASED ON MEDIAN OF ALL DATA. LOW ENRICHMENT MEDIAN ≦ 400 UG/L, MODERATELY ENRICHED MEDIAN ≧400 UG/L AND < 800 UG/L, HIGHLY ENRICHED MEDIAN ≧ 800 UG/L

Site	Total Nitrogen	
	Median in ug/l	Status
Ogden Confluence	334.5	Low Enrichment
Ogden Wall Ave	349	Low Enrichment
Ogden at Canyon Mouth	295	Low Enrichment
Ogden at Canyon Mouth Rep	322	Low Enrichment
Wheeler abv Ogden	327	Low Enrichment
NF Ogden Lower	1100	Highly Enriched
MF Ogden	216	Low Enrichment
SF Ogden	514	Moderately Enriched

Phosphorus

Total phosphorus is the measurement of all forms of phosphorus in the water sample including both organic and inorganic forms. Boxplots for total phosphorus are provided in Figure 4. Boxplots for other phosphorus characteristics are included in APPENDIX II to provide supporting data. Water quality sample data was compared to numeric nutrient criteria established for total phosphorus (Table 5). The median for all water quality samples were within the low total and dissolved phosphorus enrichment status (Table 7).

TABLE 7. SUMMARY OF PHOSPHORUS ENRICHMENT LEVEL AT ALL SITES. NUTRIENT CATEGORIES FOR SAMPLE SITES BASED ON MEDIAN OF ALL DATA. LOW ENRICHMENT MEDIAN ≦ 35 UG/L, MODERATELY ENRICHED MEDIAN ≧35 UG/L AND < 80 UG/L, HIGHLY ENRICHED MEDIAN ≧80 UG/L

Site	Total Phosphorus	
	Median in ug/l	Status
Ogden Confluence	15.75	Low Enrichment
Ogden Wall Ave	21.45	Low Enrichment
Ogden at Canyon Mouth	14.85	Low Enrichment
Ogden at Canyon Mouth Rep	13.7	Low Enrichment
Wheeler abv Ogden	9.5	Low Enrichment
NF Ogden Lower	10.7	Low Enrichment
MF Ogden	14.3	Low Enrichment
SF Ogden	17.1	Low Enrichment

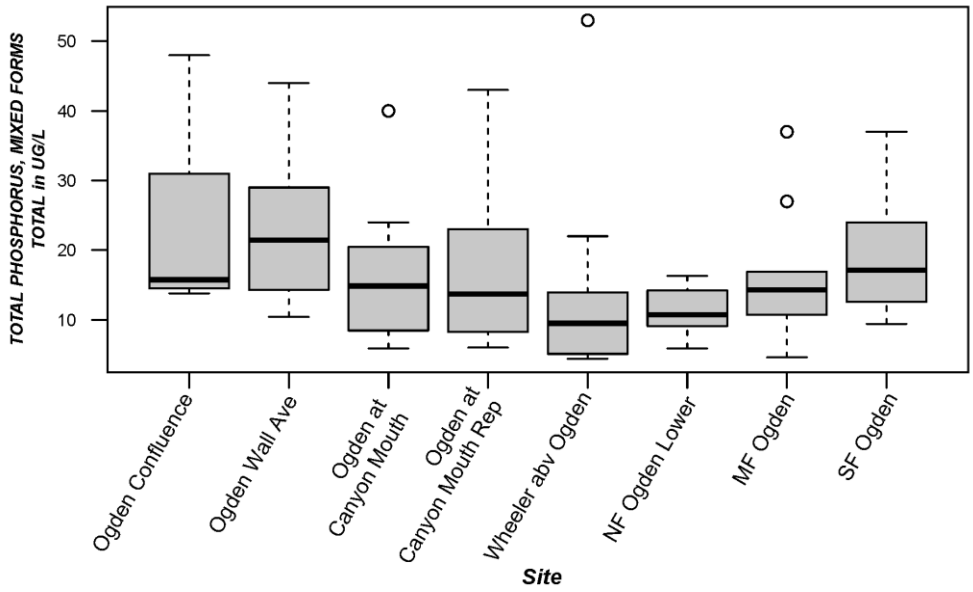


FIGURE 4. TOTAL PHOSPHORUS BOXPLOTS FOR ALL YEARS. BOXPLOTS CREATED USING NADA ROS STATISTICS

Seasonal and annual comparisons

Nutrient data for each site was compared annually and seasonally to evaluate the potential for trends. Trends for the North Fork Ogden River and South Fork Ogden River are shown as boxplots in this section due to the observed total nitrogen enrichment at both sites. Data for boxplots is provided in the boxplotStats.xlsx workbook (enclosed). Seasonal and annual boxplots for all other sites with low nitrogen enrichment are included in APPENDIX III. Caution should be used when making determinations based on these generally small datasets. Annual trends were not observed with the available data at any site. Seasonal variability in total nitrogen concentrations were observed at the North Fork Ogden River and South Fork Ogden River with higher winter median concentrations (Figure 5, Figure 6).

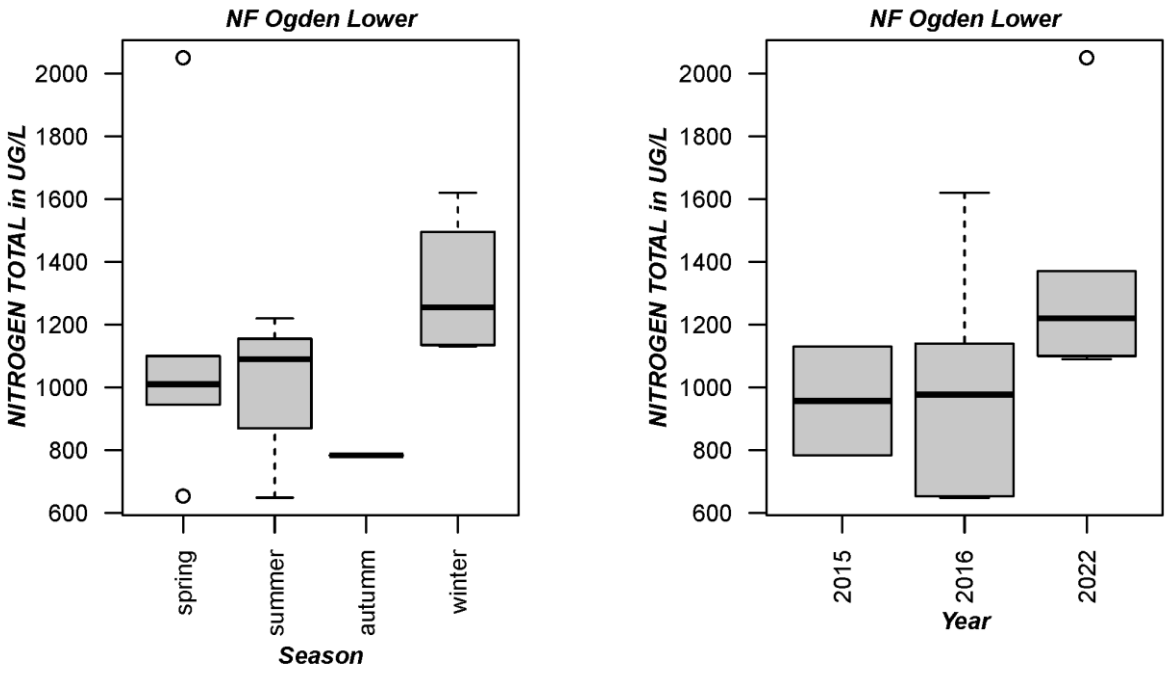


FIGURE 5. SEASONAL AND ANNUAL TOTAL NITROGEN BOXPLOTS FOR THE NORTH FORK OGDEN RIVER

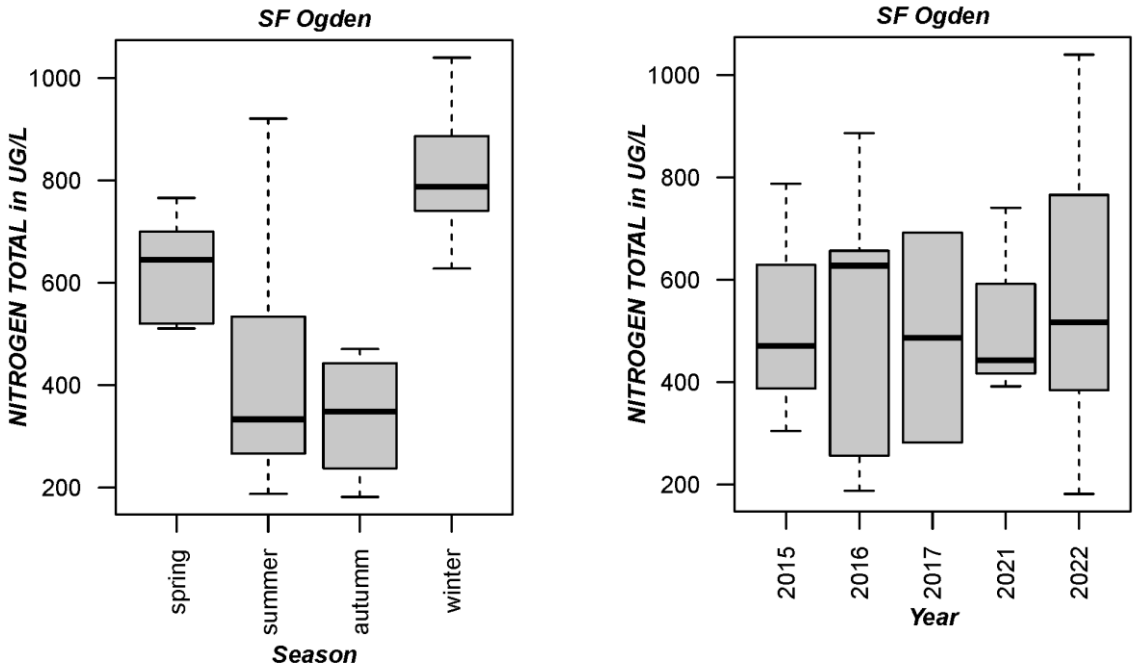


FIGURE 6. SEASONAL AND ANNUAL TOTAL NITROGEN BOXPLOTS FOR SOUTH FORK OGDEN RIVER

2.2. Assessment units, classification, and beneficial uses

Assessment units (AUs) are discrete surface waters identified and delineated for 303(d) assessments. These units identify waters of the state assessed for support of their designated beneficial uses. Lakes, reservoirs, and ponds are delineated as individual AUs. Flowing surface waters of the state are delineated by specific rivers, or one or more surface water reaches in subwatersheds. Assessment units within the Ogden River Watershed and their assigned beneficial use class are listed in Table 8 and shown in Figure 7. Definitions of beneficial use classes identified in the Ogden River Watershed are provided in Table 9.

TABLE 8. ASSESSMENT UNITS IN THE OGDEN RIVER WATERSHED AND BENEFICIAL USE CLASS

Assessment Unit Id	Assessment Unit Name	Beneficial Use Class
UT16020102-008_00	Wheeler Creek	1C, 2B, 3A, 4
UT16020102-005_00	Ogden River-1	2A, 3A, 4
UT16020102-010_00	South Fork Ogden River-1	1C, 2B, 3A, 4
UT-L-16020102-014_00	Pineview Reservoir	1C, 2A, 3A, 4
UT16020102-006_00	North Fork Ogden River	1C, 2B, 3A, 4
UT16020102-009_00	Middle Fork Ogden River	1C, 2B, 3A, 4

TABLE 9. DEFINITION OF BENEFICIAL USE CLASSES APPLICABLE TO THE OGDEN RIVER WATERSHED PROJECT AREA (UTAH DIVISION OF WATER QUALITY 2021)

Beneficial Use Subclassification	Definition
1C*	Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water
2A	Protected for frequent primary contact recreation where there is a high likelihood of ingestion of water or a high degree of bodily contact with the water. Examples include, but are not limited to, swimming, rafting, kayaking, diving, and water skiing.
2B	Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.
3A*	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
4	Protected for agricultural uses including irrigation of crops and stock watering.
*Footnote: There are human health (HH) criteria associated with these beneficial uses in UAC R317-2. For uses with a HH criteria, (see Table 2.14.6 in UAC R317-2), the following use notation will be used in 303(d) data and assessment reports: HH1C, HH3A, HH3B, HH3C, and HH3D.	

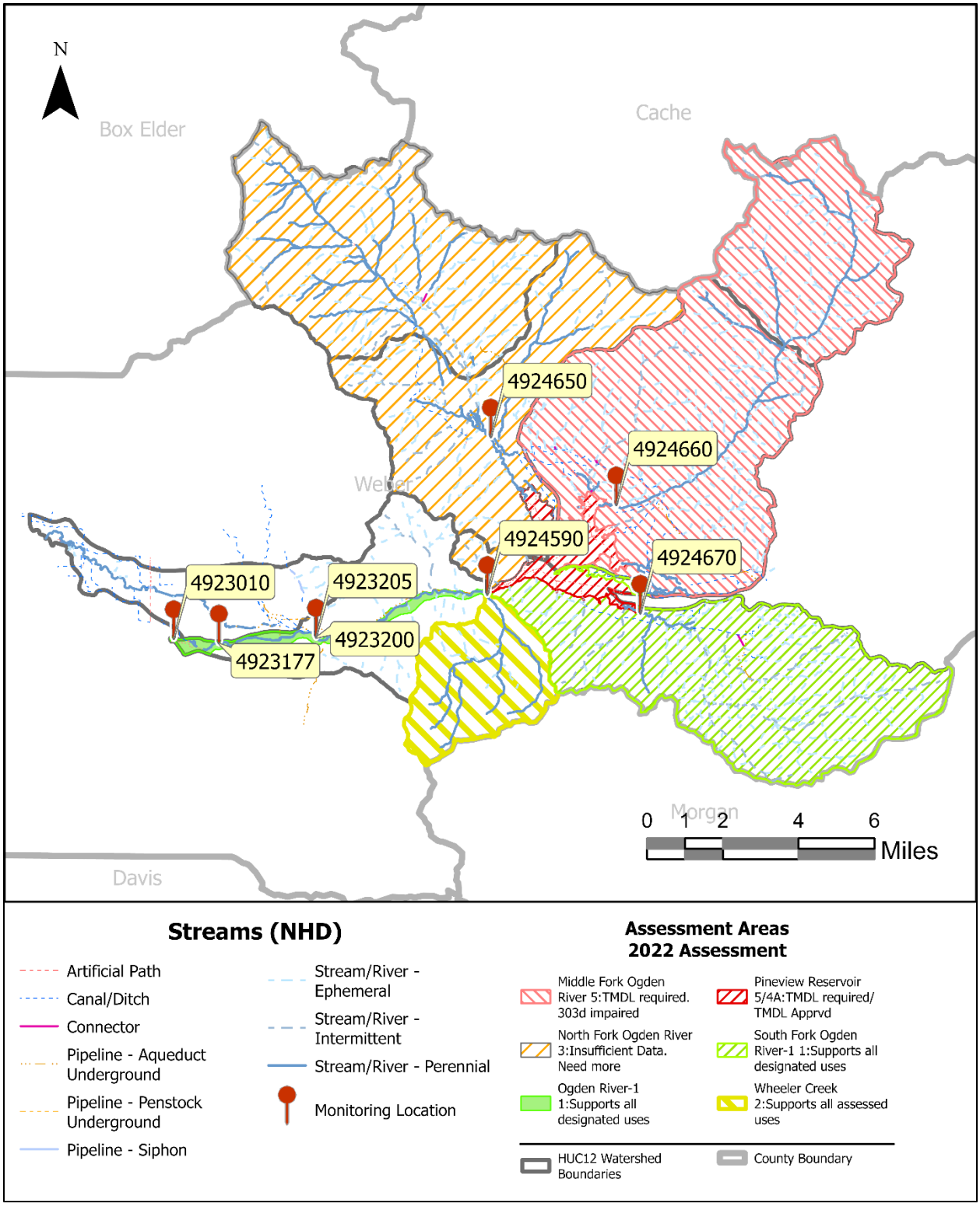


FIGURE 7. ASSESSMENT UNITS WITHIN THE OGDEN RIVER WATERSHED

The Middle Fork Ogden River does not meet water quality standards due to impaired dissolved oxygen levels, and the South Fork Ogden River currently does not meet water quality standards due to nutrient and eutrophication (Table 10). Both of these rivers flow into Pineview Reservoir which does not meet water quality standards for Dissolved Oxygen, pH, total phosphorus, and temperature. All parameters at Pineview Reservoir except temperature have an approved TMDL. The TMDL recommended a beneficial use change from cold to warm water aquatic life (Tetra Tech, Inc, 2002), but that recommendation has not been implemented The Middle Fork Ogden River is listed as needing a TMDL for dissolved oxygen (UDWQ, 2022).

TABLE 10. SUMMARY OF PREVIOUS ASSESSMENT CLASSIFICATION (UDWQ 2021), CURRENT ASSESSMENT RATING (UDWQ 2022), AND SECTION 303(D) LIST OF IMPAIRMENT AT ASSESSMENT UNITS WITHIN THE OGDEN RIVER WATERSHED

Assessment Unit Name	2018/2020 Integrated Report	2022 Assessment	Impairment
Wheeler Creek	3: Insufficient Data	1:Fully supporting	
Ogden River-1	3: Insufficient Data	1:Fully supporting	
South Fork Ogden River-1	3: Insufficient Data	5: Not supporting. 4C Assessment- Non pollutant impairment.	Use Class 3A: Nutrient/Eutrophication. Biological indicators
Pineview Reservoir	5: Not Supporting - 3A: Maximum Temperature; pH 4: Approved TMDL - 3A: Minimum Dissolved Oxygen, Total Phosphorus as P	5/4A:TMDL required/TMDL Approved	Use Class 3A: Temperature, Dissolved Oxygen, Total Phosphorus, pH
North Fork Ogden River	2: No evidence of impairment	2: No evidence of impairment	
Middle Fork Ogden River	5: Not supporting -3A: Minimum Dissolved Oxygen	5:Not supporting. TMDL needed. 303d impaired. DO	Use Class 3A: Dissolved Oxygen

2.3. Land use

Land use was determined using the NLCD (Dewitz, 2021). NLCD includes remotely mapped land cover data for 2001, 2004, 2006, 2011, 2013, 2016, and 2019. The land cover for 2019 is shown in Figure 8. Land cover classification description for these figures is provided in Table 11. All NLCD coverage years are provided in APPENDIX IV. Land use is a determining factor in the types of pollutant loading and best management practices applicable to a stream reach.

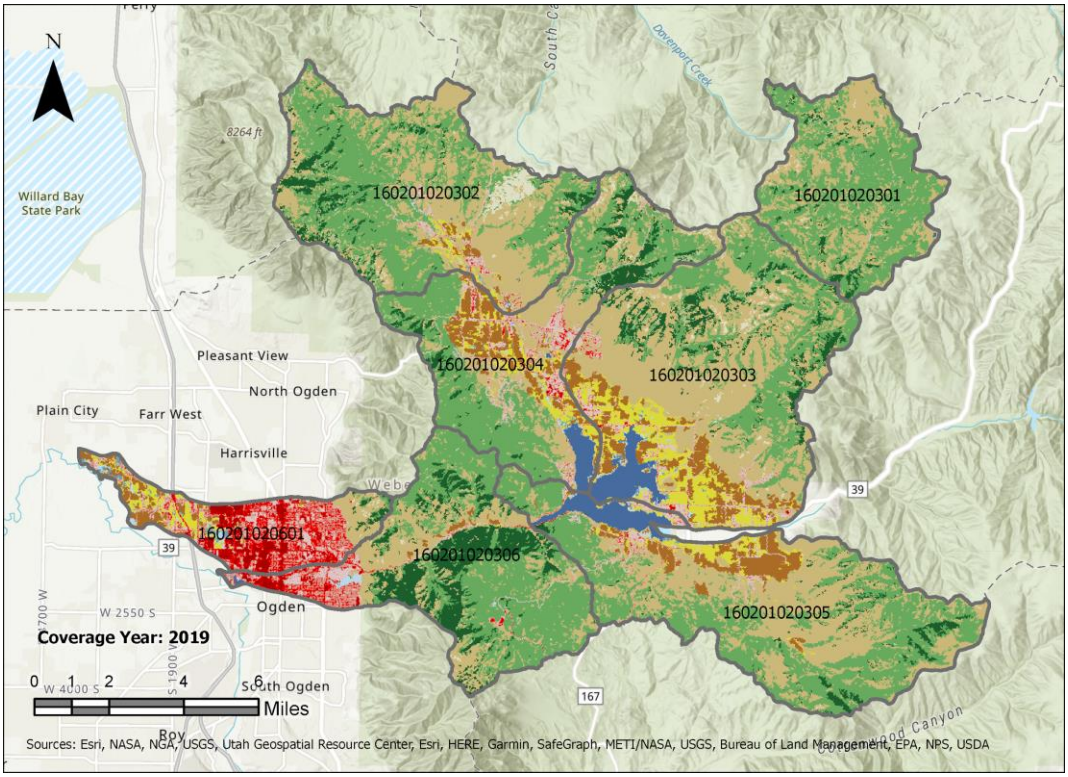


FIGURE 8. OGDEN RIVER WATERSHED LAND COVER FOR 2019 (NLCD)

A summary of land cover by subwatershed based on the 2019 NLCD coverage is shown in Table 12. As described in Figure 8 and Table 12, land cover in the Ogden River Watershed is predominantly forest categories; the valleys are a mix of developed, pasture, and crop land. Most of the developed land cover type occurs in Mill Creek, followed by the Wheeler Creek, North Fork Ogden River, and Middle Fork Ogden River subwatersheds (Table 12).

Changes in land use are frequently correlated with changes in water quality characteristics. Changes in land use category by HUC12 were calculated for the period between 2001 and 2011 and 2011 and 2019 (APPENDIX IV). A summary of land use change from 2011 to 2019 is shown in Table 13. During this timeframe, the subwatersheds with the highest undeveloped to developed land cover type were Mill Creek (102 acres) followed by North Fork Ogden River (71 acres), Middle Fork Ogden River (38 acres), and South Branch South Fork Ogden River (35 acres) (Table 13).

TABLE 11. NATIONAL LAND COVER DATABASE CLASSES, DESCRIPTION, AND RASTER DISPLAY COLOR (DEWITZ, AND USGS JUNE 2021)

Class\ Value	Classification Description
Water	
11	Open Water- areas of open water, generally with less than 25% cover of vegetation or soil.
12	Perennial Ice/Snow- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed	
21	Developed, Open Space- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	Developed, Low Intensity- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	Developed, Medium Intensity -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	Developed High Intensity-highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
Barren	
31	Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest	
41	Deciduous Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42	Evergreen Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	Mixed Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrubland	
52	Shrub/Scrub- areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Herbaceous	
71	Grassland/Herbaceous- areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing.
Planted/Cultivated	
81	Pasture/Hay-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82	Cultivated Crops -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
90	Woody Wetlands- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	Emergent Herbaceous Wetlands- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

TABLE 12. SUMMARY OF LAND COVER TYPE BY SUBWATERSHED

HUC		Land Cover Type (acres)			
		Urban	Cropland	Pastureland	Forest
Right Fork Middle Fork Ogden River	160201020301	38	0	7	12,308
Cutler Creek-North Fork Ogden River	160201020302	559	288	314	19,575
Pineview Reservoir-Middle Fork Ogden River	160201020303	1,323	2,170	2,542	19,976
Pineview Reservoir-North Fork Ogden River	160201020304	1,743	1,521	948	13,143
Pineview Reservoir-South Branch South Fork Ogden River	160201020305	794	1,473	743	19,987
Wheeler Creek-Ogden River	160201020306	1,975	128	15	15,407
Mill Creek	160201020601	4,736	698	643	936
Total (acres)		11,168	6,279	5,212	101,332

TABLE 13. SUMMARY OF LAND COVER CHANGE BY SUBWATERSHED FROM 2011-2019

Land Cover Type Change by HUC12 in acres	Cutler Creek-North Fork Ogden River	Pineview Reservoir-South Branch South Fork Ogden River	Pineview Reservoir-Middle Fork Ogden River	Wheeler Creek-Ogden River	Pineview Reservoir-North Fork Ogden River	Right Fork Middle Fork Ogden River	Mill Creek
	160201020302	160201020305	160201020303	160201020306	160201020304	160201020301	160201020601
Area with no change in major category 2011 to 2019	19,635	23,596	26,769	16,967	17,194	12,292	7,195
Area that changed from undeveloped to developed	11	35	38	3	71	2	102
Within category changes (e.g., Pasture to cultivated crops)	35	55	233	60	138	37	132
Area converted from forest to other category (e.g., Forest to Developed)	223	59	23	42	58	106	1
Area converted to Planted/Cultivated	35	3	32	6	10	0	0
Area converted to or from open water	2	46	66	1	30	0	0
Total area classified, in acres	21,339	24,095	27,645	17,684	18,193	12,441	7,298

2.4. Discharge and stormwater permits within the Ogden River Watershed

A summary of stormwater permits by permit type and subwatershed is provided in Table 14. Detailed maps showing permit locations by subwatershed are included in APPENDIX V. The highest number of general construction permits for family housing and large-scale construction are observed at Mill Creek, North Fork Ogden River, and Middle Fork Ogden River subwatersheds (Figure 9, Table 14). A total of five dischargers with National Pollutant Discharge Elimination permits (NPDES) were identified within the watershed (Table 15); maps showing their location are included in APPENDIX V.

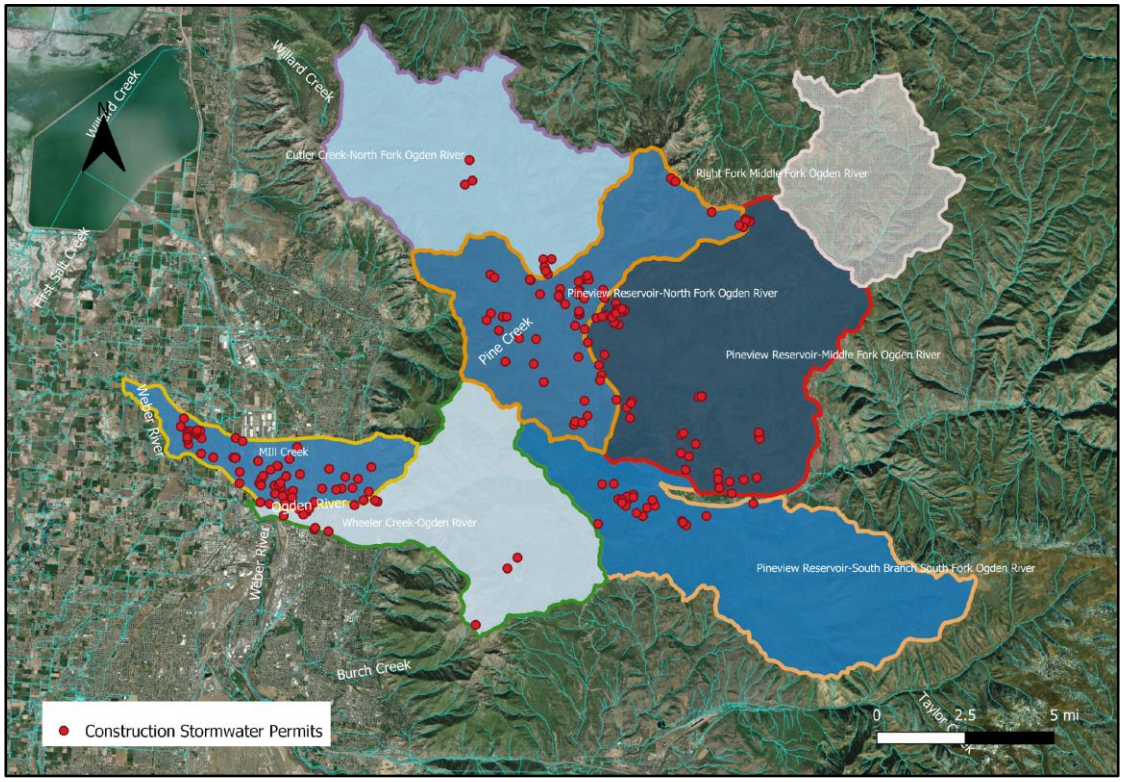


FIGURE 9. LOCATION OF CONSTRUCTION STORMWATER PERMITS WITHIN THE OGDEN RIVER WATERSHED (DARKER SUBBASIN COLOR SHADE INDICATES HIGHER POLLUTANT LOADS)

TABLE 14. STORMWATER PERMITS WITHIN THE OGDEN RIVER WATERSHED

HUC	Number of Permits by Permit Group*			
	Industrial (1)	Common Plan: family housing (2)	Construction: large scale (3)	Total
160201020301 - Right Fork Middle Fork Ogden River	0	0	0	0
160201020302 - Cutler Creek-North Fork Ogden River	0	7	2	9
160201020303 - Pineview Reservoir-Middle Fork Ogden River	0	29	20	49
160201020304 - Pineview Reservoir-North Fork Ogden River	0	48	17	65

HUC	Number of Permits by Permit Group*			
	Industrial [1]	Common Plan: family housing [2]	Construction: large scale [3]	Total
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	0	15	9	24
160201020306 - Wheeler Creek-Ogden River	1	0	13	14
160201020601 - Mill Creek	12	28	28	68
160201020301 - Right Fork Middle Fork Ogden River	0	0	0	0
Total Number of Permits**	13	127	89	229

*Stormwater Permit Types
Industrial Stormwater. Industrial Permit Group.
MSGP multi-sector industrial activity SW discharge
Construction Stormwater. Common Plan: Family housing permit group
CGP: housing project disturbance ≤1 acre SW permit
Construction Stormwater. Construction – large scale permit group
CGP: construction disturbance >1 acre SW permit
**Total number of permits with effective dates from 5/14/2019 to 5/19/22
Source: Utah Environmental Interactive Map (https://enviro.deq.utah.gov/)

TABLE 15. NATIONAL POLLUTANT DISCHARGE ELIMINATION (NPDES) PERMITS WITHIN THE OGDEN RIVER WATERSHED

NPDES_ID	Permittee	Permit Type	Effective Date	Expiration Date	Permit Group
UT0021911	CENTRAL WEBER SEWER DISTRICT	Municipal	3/6/2020	3/5/2025	Sewage Treatment Facilities
UTG070844	FL 125 17TH STREET REPLACEMENT	Construction Dewatering	7/6/2016	7/6/2017	Construction Dewatering
UT0023752	FRESENIUS MEDICAL CARE	Industrial	7/15/2021	7/14/2026	Pharmaceutical Preparation Manufacturing
UTL021911	CENTRAL WEBER SEWER IMP	Biosolids	3/6/2020	3/5/2025	Materials Recovery Facilities
UT0025577	OLDCASTLE PRECAST	Industrial	12/1/2019	11/30/2024	Concrete Pipe Manufacturing

2.5. Soil erosion potential

An erosion potential model (or risk area model) was developed for the Ogden River Watershed as a tool to help identify critical areas and potential areas of degradation. The approach for this model development was based on previous Conservation Effects Assessment Project (CEAP) investigations intended to evaluate the placement of BMPs in the landscape, and to make recommendations to policymakers, agricultural conservation field staff, and land owners or managers to ensure that future management efforts are targeted towards the most effective and socioeconomically viable BMPs.

The model to predict soil erosion by water and subsequently assess critical areas in the watershed was based on Renard, 1997 and Laflen, 2013. Below is a summary of the factors used and how they were calculated. The model input factors are shown in Figure 10 and model output is shown in Figure 11.

K-factor Erodibility

Soil erodibility **(**KFFACT) quantifies the susceptibility of soil particles to detach and move via water. This factor is used in the Universal Soil Loss Equation (USLE) to calculate soil loss by water. Erodibility factor is a value between 0 and 1.

R-factor Precipitation

Annual average precipitation of 30 years in millimeters (mm).

C-factor Land cover

The C-factor is a crop management value that represents the ratio of soil erosion from a specific cover type compared to the erosion that would occur on a clean-tilled fallow field under identical slope and rainfall. The C-factor integrates several variables that influence erosion including vegetative cover, plant litter, soil surface, and land management. Original ULSE C-factors were experimentally determined for agricultural crops and have since been modified to include rangeland and forested land cover types. For this assessment, the C-factor was estimated for various land cover types using the NLCD and C-factor interpretations were applied during previous USLE modeling projects (Montana DEQ and EPA Region 8, 2014). C-factor land cover values used are listed in Table 16.

LS-factor

The S-factor measures the effect of slope steepness, and the L-factor defines the impact of slope length. The combined LS-factor describes the effect of topography on soil erosion (Laflen, 2013) (Panagos, 2015). The grid-cell size is very important for the S-factor, since the slope decreases as the cell size increases; thus, we selected the highest-available-resolution digital elevation model (DEM) of 10m.

S-factor equation for LS:

$$\text{S-factor} = (0.43 + 0.30*s + 0.043*s^2)/6.613$$

where S is the percentage of slope gradient

TABLE 16. C-FACTOR VALUES FOR USLE MODEL

NLCD Land	Value in the model
Unclassified	NA
Open Water	NA
Perennial Snow/Ice	NA
Developed, Open Space	0.003
Developed, Low Intensity	0.001
Developed, Medium Intensity	0.001
Developed, High Intensity	0.001
Barren Land	0.001
Deciduous Forest	0.003
Evergreen Forest	0.003
Mixed Forest	0.003
Shrub/Scrub	0.008
Herbaceous	0.013
Hay/Pasture	0.013
Cultivated Crops	0.013
Woody Wetlands	0.03
Emergent Herbaceous Wetlands	0.003

L-factor equation for LS:

$$\text{L-factor} = \lambda/22.12^{m}$$

Where 22.12 is used for meters (or 72.6 for feet) and m is the slope length exponent

m = 0.5 if the percentage of slope gradient is higher 5
m = 0.4 if the percentage of slope gradient is between 3 and 5
m = 0.3 if the percentage of slope gradient is between 1 and 3
m = 0.2 if the percentage of slope gradient is less 1

P-factor practice factor

P-factor practice factor was not included in the model since this project still does not have field data to estimate this factor of the USLE equation. The P-factor, or conservation practice factor, is a function of the land management practice. It incorporates the use of erosion control practices such as strip cropping, terracing, and contouring, and is applicable only to agricultural lands.

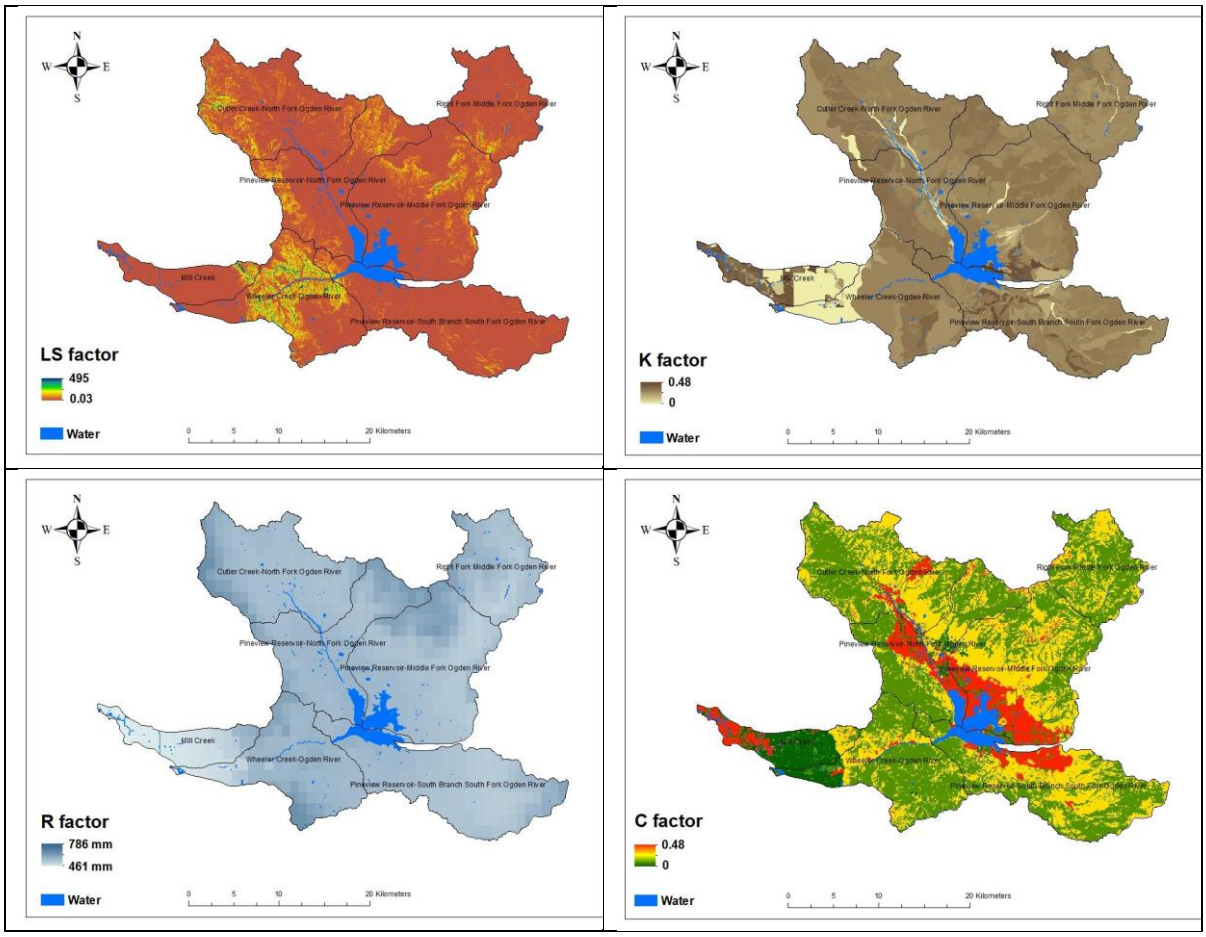


FIGURE 10. FACTORS USED FOR DEVELOPMENT OF SOIL EROSION POTENTIAL MODEL (A) LS- LENGTH AND SLOPE LENGTH, (B) K-SOIL ERODIBILITY. (C) R-PRECIPITATION, (D) C-LAND COVER

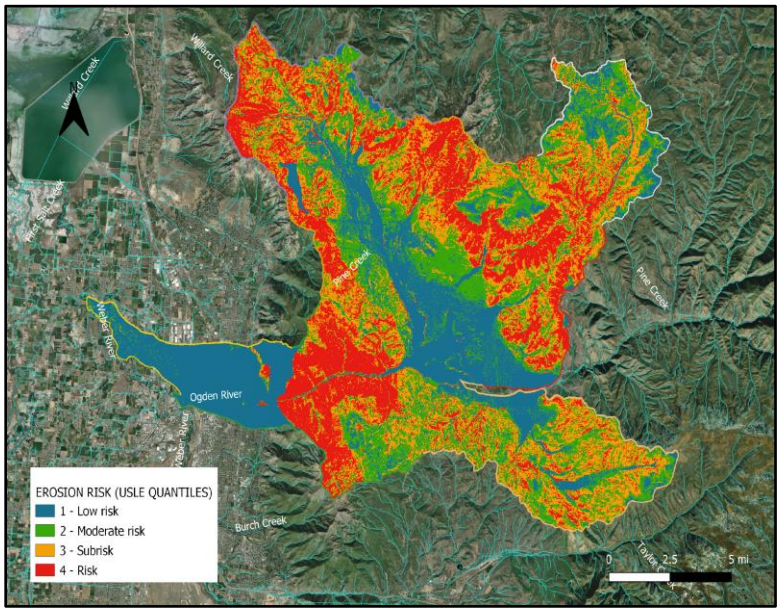


FIGURE 11. OGDEN RIVER WATERSHED MODEL OF SOIL EROSION POTENTIAL FOR ASSESSMENT OF CRITICAL AREAS

3. Vision, goals, and targets

3.1. Issues and areas of concern

Public and stakeholder meetings were conducted to introduce the rationale and approach to the plan effort. These meetings, along with a survey, allowed people with an interest in the project to share their thoughts about areas or concern, pollution sources, and goals for the plan. Issues of concern and watershed goals identified by stakeholders were listed in a stakeholder engagement report (De la Hoz, 2023) and a summary is provided below.

Participants in the watershed expressed a wide range of concerns, including issues related to land values, water and air quality, water quantity, pollution levels, watershed and ecosystem health, climate change, stream health, water availability for residents and wildlife, and population growth. Farm and ranch owners, in particular, highlighted concerns about land values, the affordability of water, and development pressure in the watershed.

Concerns regarding the Ogden River watershed's water quality and critical areas encompassed septic system pollution, development and land use changes, road-related pollution, algal blooms in Pineview Reservoir, contamination from wastewater treatment plant, urban pollution, stormwater drainage issues, the health of streams and reservoirs, excessive water use on golf courses and lawns, low summer water levels accompanied by warm temperatures and nutrient concentration, and the decline of native riparian vegetation along the Ogden River due to land use practices and housing development near riverbanks, illustrating a disconnection between watershed health and land use zoning, posing a threat to stream health.

When it comes to the Ogden River area, people are worried about several things, like pollution from septic systems, changes in how the land is used, pollution from roads, algae in Pineview Reservoir, pollution from a wastewater treatment plant, pollution from the city, issues with how rainwater is managed, the health of streams and reservoirs, too much water used on golf courses and lawns, not enough water in the summer, which makes it too warm and has too many nutrients, and a loss of natural plants along the river because of how the land is used and houses being built too close, showing that there is a gap between keeping the area healthy and the rules about how the land can be used, which can harm the streams.

3.2. Watershed plan vision and goals

Ogden River Watershed Plan Vision

Incorporating input from stakeholders, the vision for the Ogden River Watershed Plan is encompassed by the enhancement and maintenance of a thriving ecosystem within the watershed where sustainable land use planning prioritizes water quality, benefiting both wildlife and communities.

Ogden River Watershed Plan Goal

The overarching goal is to enhance water quality and management, effectively reducing pollutants to align with State water quality standards. Through concerted efforts, the plan seeks to improve water quality across the watershed, ensuring the preservation of the principal aquifer

in Ogden Valley, safeguarding vital agriculture water and existing infrastructure, and balancing development with watershed health.

In collaboration with the community, the plan intends to develop implementable strategies, elevate awareness, and foster education on responsible water use. Partnerships across the watershed will be critical for the improvement of riparian corridors, healthy stream habitats, and reduced pollution, collectively weaving a resilient tapestry of a healthy and accessible watershed for generations to come.

Stakeholder recommendations to address issues of concern

Given the issues and areas of concern, stakeholders noted the following recommendations to improve watershed health and water quality:

- Education and Awareness Enhancement: Improve public education and awareness through a range of strategies, promoting responsible water use and pollution prevention.
- Integrated Water Management and Conservation: Encourage alignment with stringent water quality standards, promote innovative agricultural practices, limit lawn water usage, control development near water bodies, manage stream ecosystems, reduce street runoff, and integrate nature-based filtration methods.
- Sustainable Infrastructure and Housing: Establish central water and sewer systems, direct medium to high density housing to sewers and advance septic systems where applicable. Require inspection, advanced septic systems for new construction, and future sewer infrastructure in developments.
- Water Infrastructure Protection: Safeguard water infrastructure and existing water rights to ensure sustained access to clean water.
- Effective Pollution Control: Develop functional settling areas and filters to mitigate pollutants entering water bodies.

These recommendations collectively aim to protect and enhance the health of the watershed, promoting sustainable water practices and preserving water quality for both current and future generations.

4. Quantitative tools to estimate pollutant loads and define priority action

Pollutant load estimation was completed using EPA's Pollution Load Estimation Tool (PLET). PLET is a simple model used to calculate nutrient and sediment loads from varying land uses and load reduction from implementation of BMPs (Tetra Tech, Inc, March 2022). PLET requires inputs for land use, agricultural animal counts, septic systems, and hydrological soil groups. This tool was used to create a model that computes watershed surface runoff, nutrient loads, and sediment delivery based on land use. The tool uses the USLE and the sediment delivery ratio to calculate annual sediment load (sheet and rill erosion only). The sediment and pollutant load reductions due to BMP implementation are calculated using known BMP efficiencies (Tetra Tech, Inc, March 2022). Land use data for input in PLET is described above in Section 2.2.

Other PLET inputs are summarized below, and the input dataset is included as a separate Excel file (Ogden River 9-Element Watershed Plan_input.xls).

On-site septic system data

The PLET requires inputs for the number of septic systems, the population per septic system, and the septic failure rate. The upper basin area upstream of the mouth of Ogden Canyon includes a considerable number of residences that are second homes and require additional assessment to estimate the population served by septic systems in these areas. Septic tank inputs for the number of septic systems and population per septic system were calculated using the method described by the UGS water quality and quantity study of groundwater in the Ogden Valley (Jordan et al., 2019). Housing units within the limits of the valley-fill aquifer or downstream of Pineview Reservoir not within the service area of sewage lagoons or sewer districts were used as a surrogate for the number of septic systems, described below. Estimates of population per septic system were developed from census population data and total number of housing units within each census tract. This approach is also described in more detail below.

Development patterns within the watershed and geographic boundaries identified two census tracts to be included in the estimate: tracts 2101.01 and 2101.02 (Figure 12). These two census tracts include all areas upstream of Pineview Reservoir and the area downstream of Pineview Reservoir to the mouth of Ogden Canyon. The remaining area within the Ogden River Watershed (part of Mill Creek and Wheeler Creek HUCs) are more densely developed and are serviced by the Central Weber Sewer Improvement District. Outlines for the sewage lagoon and sewer district service areas above Pineview Reservoir were provided by (Jordan L. , 2023).

Weber County parcel data were used to estimate the number of housing units within each census tract. To estimate the number of septic systems, the Weber County parcel data provided by Weber County (McBride, 2023) were summarized based on use type and 2020 census tract data, evaluating only the 2101.01 and 2101.02 census tracts. The primary use categories were each assigned the probable number of residences based on the primary use. Where a range of residences were provided the average of the range was used, for example 112 – Duplex Unit was assigned 2 residential units (Table 17).

TABLE 17. PRIMARY USE CODE AND NUMBER OF ESTIMATED RESIDENTIAL UNITS PER PARCEL, ONLY PARCEL TYPES IN CENSUS TRACT 2101.01 AND 2101.02 WITH AT LEAST ONE RESIDENTIAL UNIT SHOWN

Primary Use Code	Residences per parcel
108 - SFR on COMM Zone	1
111 - SNGL FAM RES	1
112 - DUPLEX	2
116 - CONDO	1
122 - TWIN_HOME	2
133 - 3+Connected_SFR	3
160-MOBILE HOME PARK	40
196 - SINGLE FAM RES(DNFM)	1
508 - Both RES & COMM IMPRVD	1

The number of residential units was calculated by multiplying the number of parcels in each primary use category by the number of residences associated with that primary use category and summing the result. The estimated number of residential units for each census tract is shown in Table 18.

TABLE 18. CENSUS POPULATION, RESIDENTIAL UNITS, AND ESTIMATED POPULATION PER RESIDENCE BY CENSUS TRACT

Census Tract	Census Population	Total Residential Units	Estimated Full Time Residential Units	Estimated Part Time Residential Units	Estimated Part Time Residents	Full-Time + Part Time Residents	Estimated People Per Residence
2101.01	3,965	1,941	1,358	583	851	4,816	2.48
2101.02	4,301	2,342	1,473	869	1269	5,570	2.38
Total	8,266	4,283	2,831	1,452	2,120	10,386	2.42

The population estimates were adjusted for seasonal occupancy following methods described in the UGS hydrogeology study (Jordan et al., 2019) and outlined below. The Weber County average persons per household (PPH) of 2.92 was assumed to also apply within the Ogden River Watershed area (United States Census Bureau, 2023). Taking the population census for each area and dividing it by 2.92 PPH estimates the number of parcels that are occupied. The remaining parcels were assumed to be second homes occupied 50% of the time with the same PPH load.

[POPULATION CENSUS AREA] ÷2.92 PPH = [Full Time Residential Units]

[Residential Units] – [Full Time Residential Units] = [Part Time Residential Units]

[Part Time Residential Units] * 2.92 PPH *50% Occupancy = [Part Time Residents]

{[Population Census Area] + [Part Time Residents]}/[Residential Units] = Average PPH

The number of residential units without wastewater treatment plant service (as surrogate for number residential units with onsite septic systems) within the Ogden River Watershed is shown in Table 19 and Figure 12. Only parcels outside of a wastewater treatment plant or lagoon service areas were included in these calculations. Estimates for each subwatershed were based on developed parcel data for each HUC with the assigned average person per household calculated above.

The subwatershed with the highest estimated number of onsite septic systems is North Fork Ogden River, followed by Middle Fork Ogden River and South Branch South Fork Ogden River (Table 19).

TABLE 19. CALCULATED NUMBER OF RESIDENTIAL UNITS WITHOUT WASTEWATER TREATMENT PLANT SERVICE IN THE OGDEN RIVER WATERSHED

HUC	Number of Residential Units Without WWTP Service (surrogate for number of onsite septic systems)
160201020301 - Right Fork Middle Fork Ogden River	7
160201020302 - Cutler Creek-North Fork Ogden River	263
160201020303 - Pineview Reservoir-Middle Fork Ogden River	649
160201020304 - Pineview Reservoir-North Fork Ogden River	898
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	609
160201020306 - Wheeler Creek-Ogden River	169
160201020601 - Mill Creek	0
Total	**2,595**

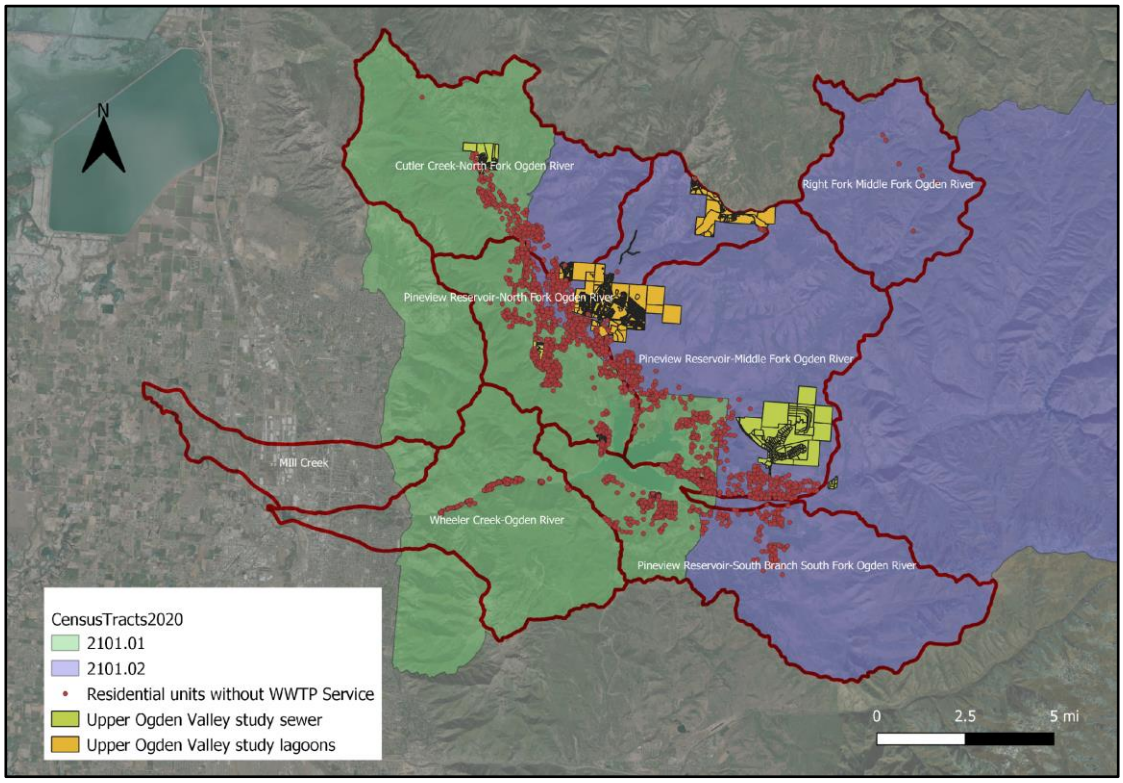


FIGURE 12. CENSUS TRACTS WITHIN THE OGDEN RIVER WATERSHED AND RESIDENTIAL PARCELS WITHOUT WASTEWATER TREATMENT PLANT SERVICE (SURROGATE FOR ONSITE SEPTIC SYSTEMS)

Animal counts

Animal counts were distributed based on feedlot acreage as shown in Table 20. Cow and sheep total counts for Ogden Valley were provided by the USDA Farm Service Agency (Combe, 2023). Horse counts were based on the 2002 Pineview TMDL (Tetra Tech, Inc, 2002).

TABLE 20. ANIMAL COUNT AND DISTRIBUTION BY HUC. ANIMAL COUNTS WERE DISTRIBUTED PRO-RATA BASED ON FEEDLOT ACRES FROM PLET BASE MODEL

Feedlot Acres And Animal Type	HUC							Total	
	1602010 20302	1602010 20305	1602010 20303	1602010 20306	1602010 20304	1602010 20301	1602010 20601		
	Cutler Creek-North Fork Ogden River	Pineview Reservoir-South Branch South Fork Ogden River	Pineview Reservoir-Middle Fork Ogden River	Wheeler Creek-Ogden River	Pineview Reservoir-North Fork Ogden River	Right Fork Middle Fork Ogden River	Mill Creek		
Feedlot Acres	0.34	0.94	1.86	0.05	1.14	0.00	0.50	4.83	acres
Cows	70	195	385	10	236	0	104	1000	animals
Sheep	211	584	1155	31	708	0	311	3000	animals
Horses	35	97	193	5	118	0	52	500	animals

5. Pollutant loading and sources of pollution

As noted in Section 2.1, water quality data analysis showed that sites at North Fork Ogden River Lower and South Fork Ogden River presented high and moderate total nitrogen enrichment, respectively (Table 6). In contrast, low phosphorus enrichment was evident across all sites in the watershed (Table 7). Consequently, the following pollutant loading, and source analysis emphasizes nitrogen loading. Nitrogen, phosphorus, and sediment loads in the Ogden River Watershed are depicted in Figure 13.

The pollutant load estimation based on PLET indicated that about half of the nitrogen load within the Ogden River Watershed comes from the Middle Fork Ogden River (27%) and the North Fork Ogden River (21%). Substantial nitrogen loads were also evident at South Branch South Fork Ogden River (16%) and Mill Creek (19%; Table 21, Figure 14). The middle and north forks of the Ogden River also accounted for a substantial contribution of phosphorus and sediment to the pollutant loads within the watershed (Table 21).

Pollutant load estimates by source indicated that 32 percent of the nitrogen load in the Ogden River Watershed is associated with urban land use; cultivated and pasture lands contributed 22 and 14 percent of the total nitrogen load, respectively (Figure 13, Table 22). Onsite septic systems, predominant in the Ogden Valley (Figure 12), accounted for 11 percent of the nitrogen load across the watershed.

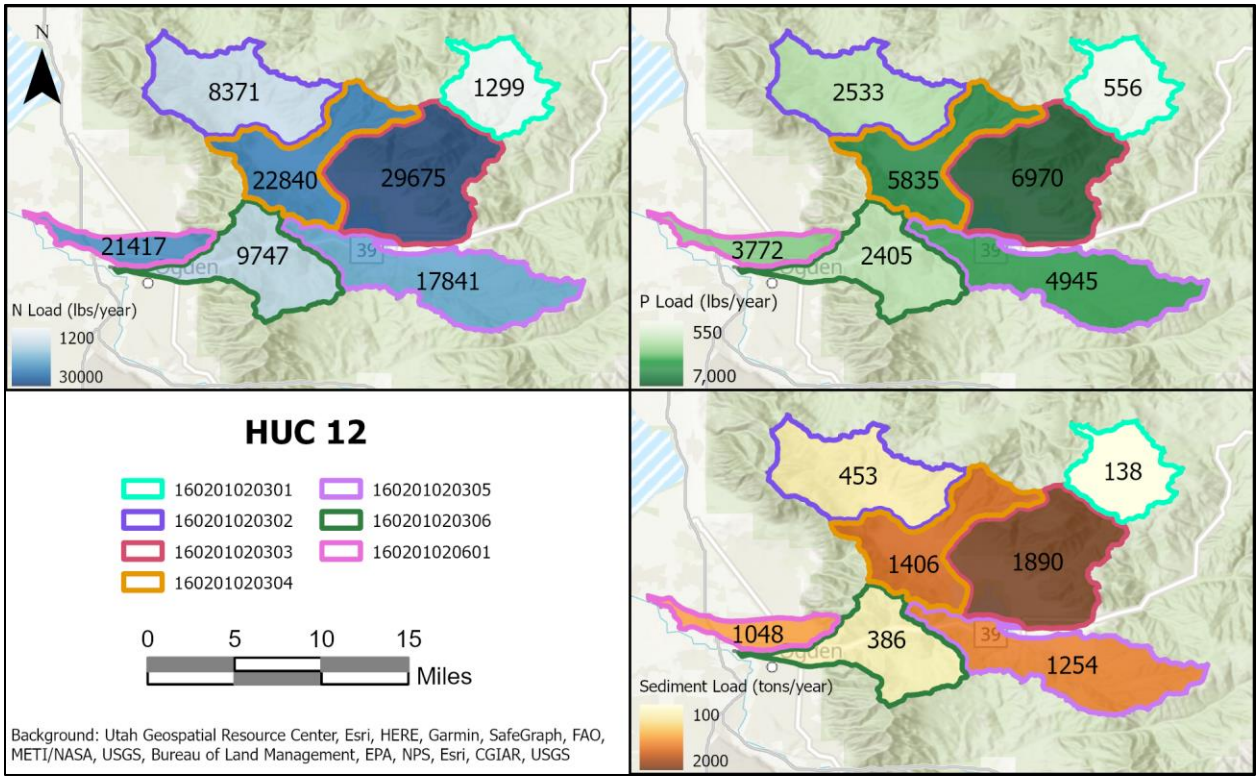


FIGURE 13. NITROGEN, PHOSPHORUS, AND SEDIMENT LOAD (PLET) ESTIMATES IN THE OGDEN RIVER WATERSHED

TABLE 21. NITROGEN, PHOSPHORUS, AND SEDIMENT PLET LOAD ESTIMATES WITHIN THE OGDEN RIVER WATERSHED BY HUC12

HUC	N Load (No BMP)			P Load (No BMP)			Sediment Load (No BMP)		
	(lbs/year)	(tons/year)	(%)	(lbs/year)	(tons/year)	(%)	(lbs/year)	(tons/year)	(%)
160201020301 - Right Fork Middle Fork Ogden River	1,299	0.59	1	556	0.25	2	304,238	138	2
160201020302 - Cutler Creek-North Fork Ogden River	8,371	3.80	8	2,533	1.15	9	998,693	453	7
160201020303 - Pineview Reservoir-Middle Fork Ogden River	29,675	13.46	27	6,970	3.16	26	4,166,732	1,890	29
160201020304 - Pineview Reservoir-North Fork Ogden River	22,840	10.36	21	5,835	2.65	22	3,099,696	1,406	21
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	17,841	8.09	16	4,945	2.24	18	2,764,593	1,254	19
160201020306 - Wheeler Creek-Ogden	9,747	4.42	9	2,405	1.09	9	850,983	386	6

HUC	N Load (No BMP)			P Load (No BMP)			Sediment Load (No BMP)		
	(lbs/year)	(tons/year)	(%)	(lbs/year)	(tons/year)	(%)	(lbs/year)	(tons/year)	(%)
River									
160201020601 - Mill Creek	21,417	9.71	19	3,772	1.71	14	2,310,442	1,048	16
TOTAL	**111,189**	**50.43**		**27,017**	**12.25**		**14,493,172**	**6,574**	

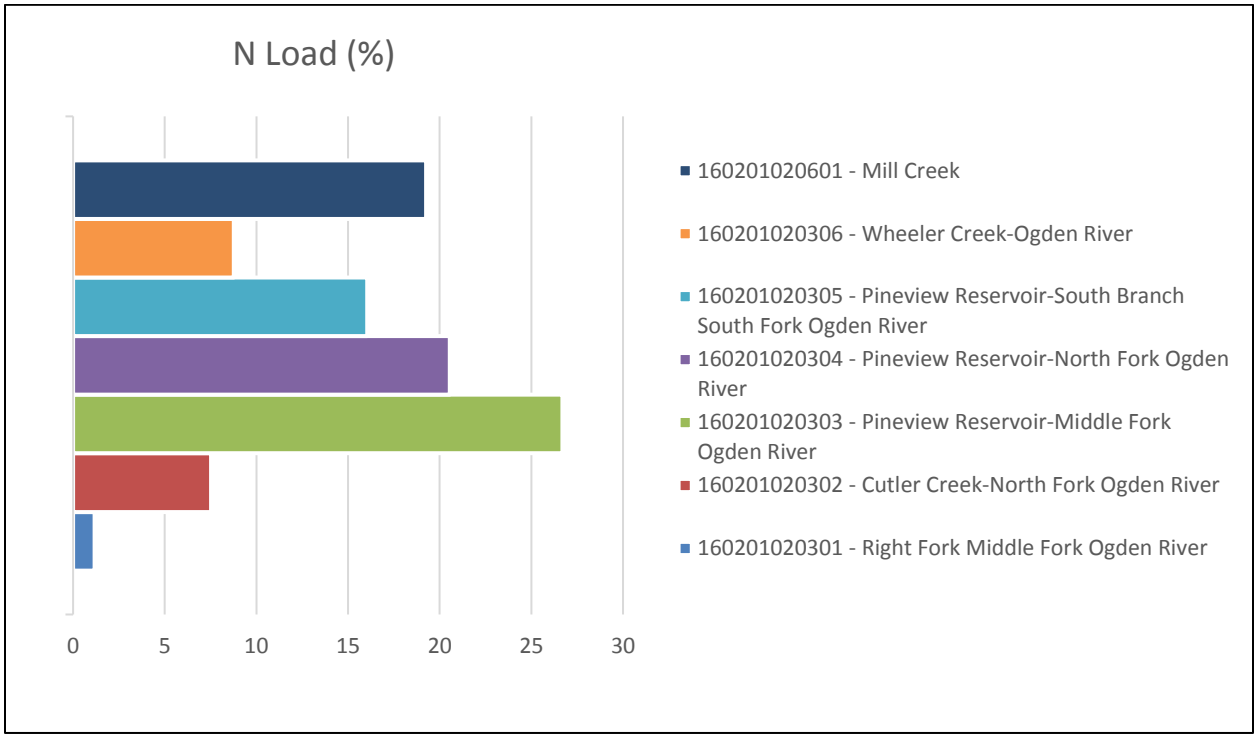


FIGURE 14. PERCENT NITROGEN LOAD BY SUBWATERSHED

By separating the estimated nitrogen load by HUC12 and source, it was observed that a substantial amount of nitrogen from urban sources is associated with Mill Creek (Figure 15). At the three Pineview Reservoir HUCs (i.e., Middle Fork Ogden River, North Fork Ogden River, and South Branch South Fork Ogden River), in the absence of BMP practices, the estimated nitrogen load from agricultural sources is greater than urban sources. Consistent with the geographic location of residential units without wastewater treatment plant service in the watershed (Figure 12), the highest nitrogen load estimated from onsite septic systems is associated with the three Pineview Reservoir HUCs (Figure 15). PLET calculations are consistent with findings in the 2002 TMDL that nonpoint sources are main contributors of pollutant loads and landscape sources are major contributors with a lower relative contribution from septic sources (Tetra Tech, Inc, 2002).

TABLE 22. NITROGEN, PHOSPHORUS, AND SEDIMENT PLET LOAD ESTIMATES WITHIN THE OGDEN RIVER WATERSHED BY SOURCE

Sources	N Load			P Load			Sediment Load		
	(lb/yr)	(tons/yr)	(%)	(lb/yr)	(tons/yr)	(%)	(lb/yr)	(tons/yr)	(%)
Cropland	24,315	11.03	22	6,816	2.74	25	2,178,165	4,096	62
Forest	12,813	5.81	12	6,043	2.48	22	1,794,561	988	15
Urban	35,396	16.06	32	5,458	2.14	20	0	814	12
Septic	12,051	5.47	11	4,720	0.95	17	0	0	0
Feedlots	10,498	4.76	9	2,100	0.85	8	1,490,323	0	0
Pastureland	16,116	7.31	14	1,880	12.25	7	14,493,172	676	10
TOTAL	111,189	50.43		27,017	3.09		9,030,124	6,574	

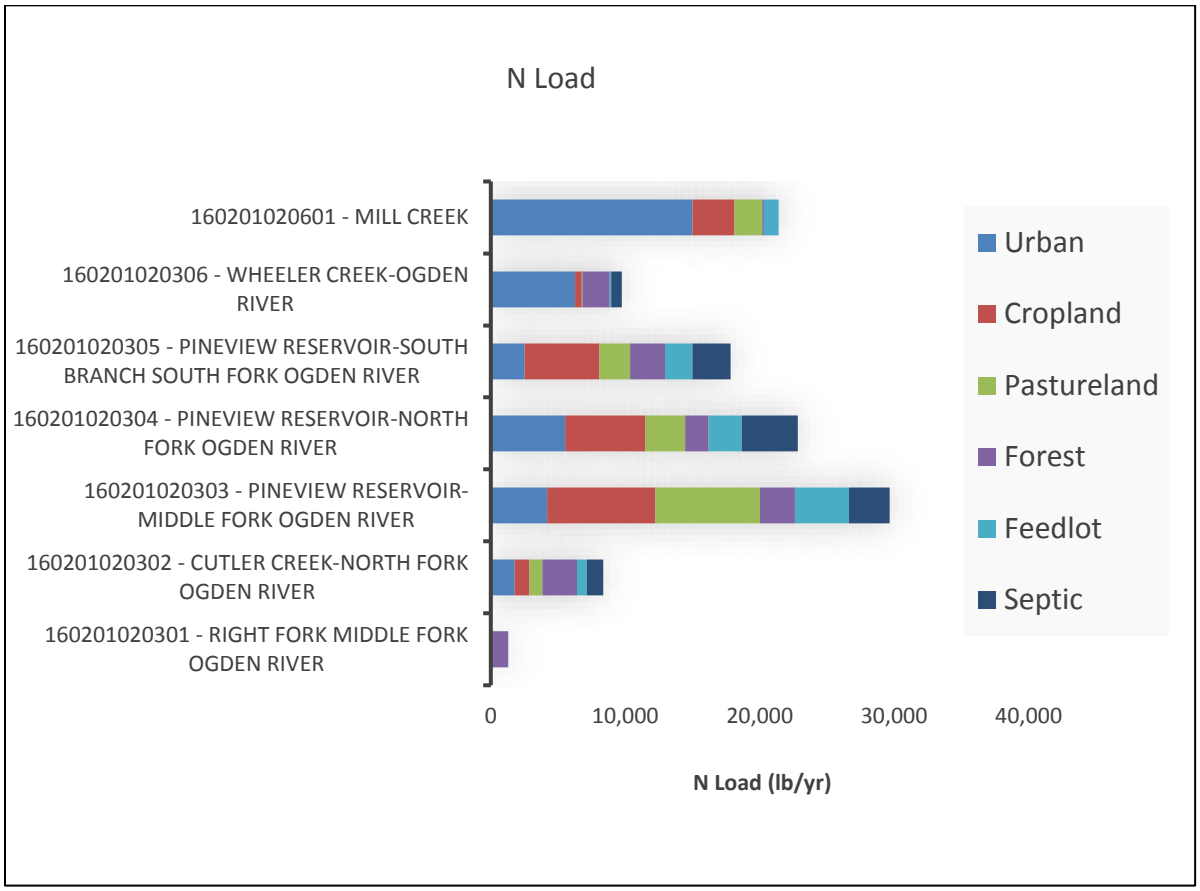


FIGURE 15. NITROGEN LOAD ESTIMATES WITHIN THE OGDEN RIVER WATERSHED BY HUC AND SOURCE

6. Priority areas and restoration strategies

Once pollutant loads were estimated and mapped, information provided by stakeholders about areas of concern and potential pollutant sources were incorporated to help rank priority areas.

Prioritization is based on pollutant loading, beneficial water use impairment, location in relation to critical areas, and stakeholder feedback.

6.1. Prioritization

Stakeholder involvement, along with the identification of critical loading areas, will help create management areas to address the nonpoint source problems. An initial prioritization for implementation is proposed for areas that are identified as impaired and, within those areas, further prioritized to include areas with the highest pollutant load estimates, having elevated nutrient enrichment levels, and areas of concern noted by stakeholders. The three Pineview Reservoir HUCs were identified as management areas with high nutrient loading, critical sources, and are considered to have the highest potential effectiveness on water quality improvement given the estimated nutrient loads (Table 23). The three Pineview Reservoir HUCs also encompass areas where a high number of general construction permits, and on-site septic systems were documented (see Table 14 and Table 19).

TABLE 23. PRIORITY RANKING FOR OGDEN RIVER SUBWATERSHEDS

HUC	Total N load (lbs/year)	Total P load (lbs/year)	Assessment Unit and corresponding 2022 Assessment		WQ Monitoring Site and Total Nitrogen Enrichment Level		Priority Ranking
160201020303 - Pineview Reservoir-Middle Fork Ogden River	29,675	6,970	Middle Fork Ogden River	5:Not supporting. TMDL needed. 303d impaired	MF Ogden - 4924660	Low	High
160201020304 - Pineview Reservoir-North Fork Ogden River	22,840	5,835	North Fork Ogden River	2: No evidence of impairment	NF Ogden Lower - 4924650	High	High
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	17,841	4,945	South Fork Ogden River-1	5: Not supporting. 4C Assessment-Non pollutant impairment.	SF Ogden - 4924670	Moderate	Moderate
160201020301 - Right Fork Middle Fork Ogden River	1,299	556	Within Middle Fork Ogden River	5:Not supporting. TMDL needed. 303d impaired	NA	NA	Low
160201020302 - Cutler Creek-North Fork Ogden River	8,371	2,533	North Fork Ogden River	2: No evidence of impairment	NA	NA	Low
160201020601 - Mill Creek	21,417	3,772	Ogden River-1	1:Fully supporting	Ogden Confluence - 4923010	Low	Low
160201020306 - Wheeler Creek-Ogden River	9,747	2,405	Wheeler Creek - Ogden River -1	1:Fully supporting	Wheeler abv Ogden (4924590) Ogden Wall Ave (4923177) Ogden at Canyon mouth (4923200,	Low	Low

HUC	Total N load (lbs/year)	Total P load (lbs/year)	Assessment Unit and corresponding 2022 Assessment		WQ Monitoring Site and Total Nitrogen Enrichment Level		Priority Ranking
					rep – 4923205)		

6.2. Pollutant reduction targets

A component of this watershed plan is to consider water quality targets and goals associated with water bodies meeting their designated beneficial use. For waterbodies in the Ogden River Watershed, beneficial uses include water supply, aquatic life protection, fishing, recreation in and on the waters, and agricultural use. These uses have associated water quality standards or guidance values used to evaluate the extent to which they are supported by water quality conditions. The State of Utah has a numerical nitrogen and phosphorus criteria for protection of aquatic life and recreation in headwater streams (UDWQ, 2019). This criteria provides numerical guidance for both nutrients and the target/goal for waterbodies in the Ogden River Watershed is to achieve these standards (Table 5). Proposed pollutant reduction goals are summarized in Table 24.

TABLE 24. PROPOSED WATER QUALITY GOALS FOR OGDEN RIVER WATERSHED

Current Situation	Water Quality Goal and Pollutant Reduction Target
Waters currently meeting state standards	*Continue to meet standards* Wheeler Creek - current low TN and TP enrichment Ogden River -1 - current low TN and TP enrichment
Impaired Waters with detailed study or TMDL complete	*Create an improving trend for the parameters considered impaired.* Pineview Reservoir - achieve the 24% load reduction recommended in the TMDL necessary to address impairments (except temperature).
Impaired Waters without detailed study or TMDL	*Create an improving trend for the parameters considered impaired and parameters not currently meeting standards* Middle Fork Ogden River - Current low TN enrichment (possible Filterable N moderate enrichment). Evaluate location of monitoring station (sample may not be representative of the total subbasin load)
Not supporting. Non-pollutant impairment Nutrient/Eutrophication – Biological Indicators	South Fork Ogden River-1 - Current moderate TN enrichment. A reduction of 25% in median TN sample concentration. Or seasonal reductions in median TN concentration: fall 0%, spring 36%, summer 5%, winter 51%
Non-impaired waters not currently meeting state standards	*Create an improving trend for the parameters not currently meeting standards* North Fork Ogden River – current high TN enrichment. A reduction of 65% in median TN sample concentration (all samples). Or reductions in median TN concentration by season: Fall 49%, spring 65%, summer 59%, winter 70%

The water quality data PLET load estimates, by land cover type and subwatershed, were used to help identify potential BMPs to reduce pollutant loads in the Ogden River Watershed. Examples

of broad-based BMPs with high nitrogen removal efficiencies to address nutrient loading are listed in Table 25.

TABLE 25. EXAMPLES OF BMPS FOR THE OGDEN RIVER WATERSHED WITH BROAD APPLICABILITY

Land use Type	BMP Name
Urban	Bioretention facility
	Infiltration Basin
	Extended Wet Detention
	Filter Strip-Agricultural
Cropland	Streambank Stabilization and Fencing
	Buffer - Forest (100ft wide)
	Bioreactor
	Controlled Drainage
	Buffer - Grass (35ft wide)
	Land Retirement
	Contour Farming
	Terrace
	Conservation Tillage
	Nutrient Management
Pastureland	Grass Buffer (minimum 35 feet wide)
	Streambank Stabilization and Fencing
	Forest Buffer (minimum 35 feet wide)
	Grazing Land Management (rotational grazing with fenced areas)
Feedlots	Waste Management System
	Waste Storage Facility

7. Implementation strategy and project overview

7.1. Overview

One of the goals of the watershed plan is to identify and implement strategies that will enhance and protect water resources into the future and help reach and maintain beneficial uses. A collaborative community-driven approach is the mechanism to meet this goal. The reliance on voluntary actions to reduce nutrient export from private property is a challenge for watersheds with predominant nonpoint sources of pollution. Education and outreach are key elements to implement proposed practices. Local leaders can revise and strengthen municipal codes related to impervious cover, building on steep slopes, use and maintenance of septic systems, etc. State and federal programs offer technical support and access to some cost-sharing opportunities to agricultural sectors.

Recommendations from multiple stakeholders to address areas and issues of concern are incorporated into this watershed plan; general recommendations are listed in Section 3.2 and key categories are noted below:

- Measures to reduce the risk of sediment transport. Examples: develop functional settling areas and vegetated riparian buffers, reduce street/road runoff, control development near waterbodies, local laws for sediment and erosion control measures, steep slope ordinances, forested or vegetated riparian buffers, and winter cover crops.
- Measures to increase infiltration, and slow velocity and erosive potential of overland flow. Examples: revegetate exposed soils, stormwater ponds, road ditch improvements, forested or vegetated riparian buffers, and other green infrastructure projects to promote natural hydrology.
- Measures to reduce the risk of nutrients reaching the waterways. Examples:

  Encourage development of integrated management and conservation, improve agricultural practices, encourage installation and maintenance of forested or vegetated riparian buffers.
- Measures to reduce the risk of nutrient-enriched wastewater from individual onsite septic systems reaching surface waters and the underground aquifer in Ogden Valley.
- Measures to enhance public participation and education

Many recommended actions within the Ogden River Watershed Plan will require funding support for implementation. An overview of proposed recommended practices in various categories and implementation strategies is provided in Table 26. The proposed prioritization is based on the proposed implementation timeline. The proposed prioritization and potential partners listed should be considered a general guideline and is expected to be modified over time by stakeholder input.

7.2. Projects and load reductions

Subwatershed assessment in high priority areas (HUCs) is recommended to identify specific practices in critical areas to be targeted. Adoption of specific practices identified will help move water bodies towards meeting water quality standards. A summary of potential projects is included in Table 27. More specific cost and pollutant-removal estimates will be developed as projects are identified and selected for implementation.

7.3. Information/education activities

Preventing new sources of nutrients and sediment from reaching Pineview Reservoir and the Ogden River is critically important. Measures such as land use regulation and guidelines, education and outreach, and continued surveillance to identify and reduce erosion will affect phosphorus loading to surface waters. For example, adoption of riparian setbacks, conservation subdivision codes, steep slope ordinances, and impervious surface guidelines can help reduce adverse impacts of new development. Monitoring native riparian vegetation and treating invasive species can help maintain and stabilize riparian habitat in critical areas.

The WRP is strongly committed to outreach and public education about watershed health and best water quality management practices. The group uses multiple broad scope community

outreach and education approaches including articles contributed to print and online media outlets, an annual public information symposium, annual workshops, and newsletters.

[Remainder of Page Left Blank]

TABLE 26. IMPLEMENTATION STRATEGY AND PROJECT OVERVIEW

Category and Recommended Practice	Priority*	Potential Organizational Partners
Watershed Wide		
Continue to identify priority areas and use of conservation tools.	High	NRCS, Landowners, UDNR, FSA, UDWQ, Land Trusts, UDWQ
Develop programs to enhance and maintain natural functioning hydrology across the watershed, with emphasis on water infiltration and landscape retention.	High	Soil Conservation Districts. Land Trusts, USFS, USU Cooperative Extension, UDAF UDWQ, NRCS. FSA. Ski resorts
Encourage land conservation efforts for natural floodplains and wetlands to enhance storage and filtration of high flows, and for upslope areas, including gullies and disturbed areas, at existing and new developments to reduce erosion.	High	Landowners, Ogden Valley Planning Commission. Land Trusts, Soil Conservation District Ski resorts (Nordic Valley, Powder Mountain, Snowbasin), FWS
Expand use of riparian buffers on residential, commercial, forest, and agricultural land.	High	Landowners, municipalities, UDNR, NRCS, USFS, TU, UDAF, UDWQ
Identify, prioritize, and implement streambank stabilization projects.	High	Landowners, Soil Conservation District, TU UDNR, USFS (if practice is on public land), UDAF
Identify and prioritize key areas for construction and restoration of wetlands, wet meadows, and stream channels through reconnection of the floodplain to capture pollution and increase infiltration.	High	Landowners, Soil Conservation District, TU UDNR, USFS (if practice is on public land), Sageland Collaborative, UDWQ
Work with municipalities to review and update local codes with consideration of soil erosion, water quality, and other water resource management challenges (e.g., climate).	Medium	Municipalities. County Planning Department. Soil Conservation District, Ogden Valley Planning Commission
Reduce nutrient and sediment loss, reduce runoff and encourage water infiltration in disturbed areas (existing and new construction, ski resorts) through use of best management practices including riparian buffers, streambank stabilization, and green infrastructure. Conduct regular SWPPP compliance inspections.	High	Municipalities, Landowners, Ogden Valley Planning Commission Land Trusts. Soil Conservation District Ski resorts USFS, UDWQ

Category and Recommended Practice	Priority*	Potential Organizational Partners
Support adoption, use, and implementation of the Utah forest water quality guidelines.	Medium	Landowners, SWCDs, USFS, UDNR, UDWQ
Urban Landscape		
Expand use and funding of Green Infrastructure on private and public lands.	Medium	Landowners, Soil Conservation District, TU UDNR, USFS (if practice is on public land), Ski resorts.
Promote use of riparian buffers on residential and commercial land.	High	Landowners, Soil Conservation District, ski resorts
Continue to monitor water use. Expand use of metering systems.	Medium	Weber Basin Water Conservancy District
Roadways, Ditches, and Culverts		
Coordinate with county, municipal highway and public works departments to identify, map, and prioritize roadways, ditches, and culverts and implement remedial or enhancement measures.	High	State, county and local highway departments, UDOT. Local Roads (Ski resorts), Soil Conservation District. USFS if practice is on FS lands
Stabilize and hydroseed road ditches.	High	State, county and local highway departments, UDOT. Local Roads (Ski resorts), Soil and Water Conservation District. USFS if practice is on FS lands
Improve management of roadways, culverts, and ditches.	High	State, county and local highway departments, UDOT. Local Roads (Ski resorts), Soil and Water Conservation District. USFS if practice is on FS lands
Disconnect ditches from streams and redirect the water to detention ponds, infiltration basins, and other structures designed to enhance groundwater recharge.	High	State, county and local highway departments, Local Roads (Ski resorts), Soil and Water Conservation District. USFS if practice is on FS lands

Category and Recommended Practice	Priority*	Potential Organizational Partners
Agricultural Landscape		
Reduce nutrient and sediment loss, reduce runoff and encourage water infiltration in agricultural fields through use of best management practices including stream bank stabilization and fencing, riparian buffers, conservation tillage, crop rotations, control drainage, green infrastructure, cover crops.	High	Farmers, landowners, Soil and Water Conservation District, FSA, USDA, NRCS, UDAF and others.
Expand cooperation of agricultural support agencies to provide technical and financial support to identify and implement best management practices appropriate for individual agricultural producers.	High	Federal, State, and County partners. USDA, NRCS, FSA, UDAF
Provide technical assistance to small farms; encourage the adoption of recommended best management practices that address identified natural resource concerns.	High	Farmers, SWCDs, USDA, FSA, NRCS, UDAF
Support development and use of innovative technologies, including precision agriculture and enhanced nutrient capture.	Medium	Farmers, SWCDs, USDA NRCS, FSA, UDAF and others
Water and Wastewater Infrastructure		
Support recommended actions for regulation and maintenance of underground wastewater systems.	High	County Health Department
Encourage residents to inspect and maintain septic systems. Encourage septic system replacement of non-properly functioning units.	High	Homeowners, County Health Department
Continue to invest in wastewater collection and treatment infrastructure.	High	Municipalities, Homeowners
Promote and incentivize use of advanced septic systems to reduce nitrogen releases.	Medium	Municipalities, home owners, Health Department
Support efforts to adopt a septic inspection program.	Medium	Municipalities, home owners, Health Department

Category and Recommended Practice	Priority*	Potential Organizational Partners
Education, Outreach, Monitoring and Partnerships		
Secure funding for non-point source pollution information and education program	High	Ogden Nature Center, UDWQ
Support the WRP's role in coordinating watershed management activities.	High	UDWQ, Municipalities, County
Develop an annual work plan including recommendations for this and other relevant plans.	High	County, SCD, County Health Department, UDWQ, UDNR
Implement annual water quality monitoring programs. Revise location of water quality monitoring stations to be representative of subbasins.	High	UDWQ, County, Health Department
Continue partnerships on research, monitoring, management, and outreach.	High	Local colleges and universities, local irrigation companies, US Bureau of Reclamation (reservoir management)
Advocate for increased institutional capacity to ensure monitoring for compliance with existing regulations such as Stormwater Pollution Prevention Plan (SWPPPs).	High	County (Storm Water Management, Construction Site Management), Municipalities, UDWQ, Weber River Watershed Council
Update watershed PLET model with new data and information, including existing BMPs.	Medium	UDWQ
Increase funding for the Watershed Management Program.	Medium	Municipalities, County, UDWQ
Coordinate activities to provide Public Education, Public Involvement, and to assist in the resolution of the Illicit Discharge Detection portions of the minimum control measures for all MS4s in the county.	High	County, Ogden Nature Center, UDWQ
Public Awareness		
Promote adoption and implementation of residential guidelines to protect water quality by watershed residents.	High	Health Department, UDWQ, Ogden Nature Center
Promote strategies and practices to improve watershed communication, coordination, and capacity aimed at improving water quality.	High	UDWQ, Health department, county, municipalities, Ogden Nature Center
Coordinate watershed health improvement with the Watershed Restoration Initiative	Medium	UDNR, UDWQ, UDAF

*Prioritization is organized by high, medium, and low. High indicates a 0-2 year timeline. Medium indicates a 2-5 year timeline. Low indicates a 5-10+ year timeline.

TABLE 27. POTENTIAL PROJECTS WITH LOCATION, TARGETS, AND TIMEFRAME

Project Description	HUC12	Goal/ Target	Estimated TN reduction	Estimated TP Reduction	Time Frame	Potential Lead Organization	Estimated Cost	Potential Funding Source
Watershed Wide								
Expand use of riparian buffers on residential, commercial, forested, and agricultural land.	Watershed wide Prioritize Middle Fork North Fork South fork	Expand use of riparian buffers along 100% of stream miles of developed areas	Variable per subwatershed. Estimated TN reduction by filter strip is 1.69 lb/acre/year	Variable per subwatershed. Estimated TP reduction by filter strip is 0.30 lb/acre/year	10 years	Landowners, municipalities, UDNR, NRCS, USFS	Variable	UDWQ Utah Watershed Restoration Initiative. UDNR, USFS (if practice is on public land)
Identify, prioritize, and implement streambank stabilization projects	Watershed wide Prioritize Middle Fork North Fork South fork	Implement one priority project by subwatershed each year	Variable Estimated TN reduction by cropland streambank stabilization and fencing 2.9 lb/acre/year	Variable Estimated TN reduction by cropland streambank stabilization and fencing 0.81 lb/acre/year	10 years	Soil and Water Conservation District NRCS County UDOT	Variable	UDWQ Utah Watershed Restoration Initiative, UDNR, USFS (if practice is on public land)
Identify, prioritize and install soil erosion controls systems, e.g., bioretention, infiltration basin, dry detention, buffer – forest (100ft), buffer-grass (35 ft)	Watershed wide Prioritize Middle Fork North Fork South Fork (Use soil erosion potential map to	Implement two or more priority projects by subwatershed each year	Variable by system	Variable by system	5 years	Soil and Water Conservation District NRCS Landowners Ski resorts	Variable	UDWQ Utah Watershed Restoration Initiative. NRCS UDNR, USFS (if practice is on public land) Ski resorts

Project Description	HUC12	Goal/ Target	Estimated TN reduction	Estimated TP Reduction	Time Frame	Potential Lead Organization	Estimated Cost	Potential Funding Source
	help prioritize)							
Urban Landscape								
Expand use of riparian buffers on residential and commercial properties	Prioritize Middle Fork North Fork South Fork	Expand use of riparian buffers along 100% of stream miles within developed areas	Variable per subwatershed. Estimated TN reduction by filter strip is 1.69 lb/acre/year	Variable per subwatershed. Estimated TP reduction by filter strip is 0.30 lb/acre/year	10 years	Soil and Water Conservation District Landowners Municipalities	Variable	UDWQ Utah Watershed Restoration Initiative Landowners
Roadways, Ditches, and Culverts								
Stabilize and hydroseed road ditches. Critical area seeding. Road hydro mulch, road dry seeding	Prioritize Middle Fork North Fork South Fork (Use soil erosion potential map to help prioritize)	Stabilize 100% of road ditches	Variable per subwatershed. Estimated TN reduction by filter strip is 1.69 lb/acre/year	Variable per subwatershed. Estimated TP reduction by filter strip is 0.30 lb/acre/year	5 years	UDOT UDWQ County Municipalities	Variable	State, county and local highway departments, UDOT. Ski resorts Soil and Water Conservation District. USFW if practice is on FS lands
Agricultural Landscape								
Install soil erosion control systems in agricultural parcels. Examples: stream bank stabilization and fencing, vegetated filter strip, controlled drainage, conservation tillage, crop rotations, cover crops. Land Retirement (easements)	Prioritize Middle Fork North Fork South Fork (Use proximity to water body and soil erosion potential map as criteria to help prioritize)	Increase streambank stabilization, use of buffers at 100% of agricultural parcels adjacent to waterbodies. North Fork Enrichment	Variable by system	Variable by system	5 years	Soil Conservation District, USDA, NRCS Farmers, Landowners Land Trust UDAF	Variable by system and size	USDA, NRCS UDWQ Land Trust

Project Description	HUC12	Goal/ Target	Estimated TN reduction	Estimated TP Reduction	Time Frame	Potential Lead Organization	Estimated Cost	Potential Funding Source
		Reduction of 65% in median TN South Fork Enrichment Reduction of 25% in median TN Overall Pineview Reservoir HUCs load reduced by 24%						
Install riparian buffers on agricultural lands	Prioritize Middle Fork North Fork South Fork	Increase Riparian buffers to 100% of riparian zone along agricultural parcels North Fork Enrichment Reduction of 65% in median TN South Fork Enrichment Reduction of 25% in median TN Overall Pineview	Variable by system Estimated TN reduction by buffer - forest is 1.85 lb/acre/year By buffer – grass is 1.31 lb/acre/year	Variable by system Estimated TP reduction by buffer - forest is 0.5 lb/acre/year By buffer – grass is 0.47 lb/acre/year	10 years	Soil and Water Conservation District, USDA, NRCS Farmers, Landowners Land Trust UDAF	Variable by system size	USDA, NRCS UDWQ

Project Description	HUC12	Goal/ Target	Estimated TN reduction	Estimated TP Reduction	Time Frame	Potential Lead Organization	Estimated Cost	Potential Funding Source
		Reservoir HUCs load reduced by 24%						
Increase participation in soil and water conservation programs	Prioritize Middle Fork North Fork South Fork (Use proximity to waterbody and soil erosion potential map to help prioritize)	Increase participation	Variable according to adopted practice	Variable according to adopted practice	5 years	USDA, NRCS, FSA, Soil Conservation District, Farmers, UDAF	Variable	USDA, NRCS, Soil Conservation District
Increase use of innovative technologies, including precision agriculture and enhanced nutrient capture. Examples: sprinkler system, structure for water control, irrigation water management, nutrient management	Prioritize Middle Fork North Fork South Fork (Use proximity to waterbody and soil erosion potential map to help prioritize)	Increase flood to sprinkler irrigation	Variable by system	Variable by system	5 years	USDA, NRCS, FSA, Soil Conservation District, Farmers	Variable	Farmers, SWCDs, USDA NRCS, FSA and others
Water and Wastewater Infrastructure								
Retrofit or replace inadequate onsite septic system with advanced septic systems (N and P removing technology) Create septic system replacement fund	Prioritize Middle Fork North Fork South Fork Based on proximity to Pineview Reservoir,	Inspect 100% of standard septic systems within 100 ft of Pineview Reservoir and provide incentives for	Variable by system	Variable by system	10 years	Homeowners County Health Department	Variable	Homeowners County Municipalities State

Project Description	HUC12	Goal/ Target	Estimated TN reduction	Estimated TP Reduction	Time Frame	Potential Lead Organization	Estimated Cost	Potential Funding Source
	location of underground aquifer and geology	inspection and						
Continue to investigate and identify opportunities for sewer extension in feasible areas	Prioritize Middle Fork North Fork South Fork	Complete sewer extension feasibility studies	Variable	Variable	10 years	Municipalities	Variable	Municipalities

[Remainder of Page Left Blank]

Educational outreach plan outline

- Determine specific outreach requirements and enhance achievements by educating the public and other stakeholders.

- Customize outreach and educational initiatives by focusing on the audience, the pollutant source, and geographical location of areas (HUCs) responsible for significant nonpoint pollutant loads. Optimize outreach strategies for effectiveness and efficiency by addressing specific sources.

- Educational outreach strategies:
    - Secure funding for non-point source pollution information and education program.
    - Manage WRP website to post resources, meetings, and plans.
    - Organize hands-on volunteer days to target issues in critical areas For example, willow vegetation planting along unstable banks to reduce erosion and sedimentation, building beaver dam analogs to restore hydrology and enhance habitat for wildlife, trash and debris removal days to improve water quality and land aesthetics.
    - Attend annual events/meetings/community programs within the watershed to provide resources and extend outreach into the community i.e. WRP Confluence Meeting, Ogden Nature Center Earth Day celebration, Weber Basin Water Conservation District Fair, Weber County Fair, STEM fairs, etc.
    - Create new events and outreach materials to reach different demographics of the watershed i.e. tabeling at Pineview Reservoir to target recreationalists, tabeling at Ogden Kayak Park, post signage at trailheads and river access points.
    - Collaborate with nearby K-12 schools to boost youth engagement and awareness. This could involve establishing educational initiatives in conjunction with the Nature Academy in Huntsville; forming partnerships with organizations like the YMCA, Youth Impact, and Boys and Girls Club to engage underprivileged youth; and identifying one or more classrooms interested in adopting a stream and taking part in yearly willow planting activities.

7.4. Technical and financial assistance

This plan relies primarily on voluntary implementation of BMPs on privately owned lands, actions by local government related to land use regulations and infrastructure management, and community partnership led conservation and education efforts. Various forms of technical and financial assistance are available to help implement recommendations of the Ogden River Watershed Plan. State and federal resources, including cost-sharing and technical support, are summarized in Table 28.

TABLE 28. PROGRAMS AND RESOURCES TO SUPPORT RECOMMENDATIONS

Funding Source	Grant Program/Website Link for Additional Information	Description	Related Ogden River Watershed Plan Recommendations
STATE			
DWQ	State Nonpoint Source Grants	Hardship grant funds to help watershed programs address nonpoint source pollution. Funding can be used to implement watershed projects, education, and watershed plan development.	Agricultural Nonpoint Source Reduction Strategies. Planning and Monitoring, Pollution Control; Collaboration, Partnerships and Outreach
DWQ	Water Quality Board State Revolving Fund (SRF)	Funding for community water quality infrastructure projects including stormwater management programs, septic system density studies, and wastewater treatment and collection system upgrades.	Infrastructure and Development, Pollution Control. Water and Wastewater Management, Stormwater Management, Infrastructure and Development
UDNR	Watershed Restoration Initiative	A program with a focus on improving ecosystem values in high-priority watersheds in the state of Utah	Agricultural Nonpoint Source Reduction Strategies.
DWQ	State Nonpoint Source Grants	Hardship grant funds to help watershed programs address nonpoint source pollution. Funding can be used to implement watershed projects, education, and watershed plan development.	Water Quality Assessments, Planning and Monitoring, Pollution Control; Collaboration, Partnerships and Outreach
DWQ	Water Quality Board State Revolving Fund (SRF)	Funding for community water quality infrastructure projects including stormwater management programs, septic system density studies, and wastewater treatment and collection system upgrades.	Water Quality Assessments, Planning and Monitoring, Pollution Control; Collaboration, Partnerships and Outreach
UDNR	Watershed Restoration Initiative	A program with a focus on improving ecosystem values in high-priority watersheds in the state of Utah	Water Management, Agricultural Practices and Management, Infrastructure and Development.
FEDERAL			
EPA	Section 319	Federal funding to help with projects that reduce nonpoint source pollution. Example projects include stream restoration projects, outreach projects, irrigation improvements, and grazing management projects	Water Quality Assessments/Research, Planning and Monitoring, Pollution Control; Collaboration, Partnerships and Outreach
NRCS	EQIP	Voluntary program where agricultural producers can receive funding for structural and management practices to improve water quality, reduce soil erosion and sedimentation, improve created wildlife habitat, and mitigate drought	Agricultural Practices & Management, Forestry Management
NRCS	Agricultural Management Assistance (AMA)	A program that provides funding for production diversification and resource conservation practices that could improve water quality. Resource conservation practices include soil erosion control, integrated pest management, and organic farming	Agricultural Practices & Management. Pollution Control
NRCS	National Water Quality Initiative Program (NWQI)	Program to financially support producers implementing conservation and management practices to reduce nutrient-rich runoff. Example	Agricultural Nonpoint Source Reduction Strategies

		projects that would be eligible for funding through this grant include cover crops, filter strips, and tailwater recovery systems	
NRCS	Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP)	NRCS and the U.S. Fish and Wildlife Foundation have a partnership to provide grants for management practices that align with their priority initiatives and Farm Bill conservation programs. Agricultural landowners receive a yearly rental payment between 10 to15 years to convert agricultural land into wildlife habitat, wetland restoration areas, and permanent native grasses.	Agricultural Nonpoint Source Reduction Strategies
NRCS	Agricultural Conservation Easement Program (ACEP)	ACEP helps landowners, land trusts, and other entities protect, restore, and enhance wetlands or protect working farms and ranches through conservation easements.	Agricultural Practices & Management, Stormwater Management
NRCS	RCPP	NRCS administers RCPP funding pools for private-public partnerships to implement agricultural best management practices on critical conservation area lands and through state or multi-state funding pools. RCPP project applications may identify a range of conservation activities to be implemented by farmers, ranchers, and forest landowners.	Agricultural Nonpoint Source Reduction Strategies
NRCS	Conservation Innovation Grants (CIG)	A program that targets funding for individual producers and smaller organizations that may not compete well on larger state and federal grants. This funding targets different categories of projects per year, and updated categories can be found on the NRCS website. Example categories of projects include soil health, water optimization technologies, and urban farming technologies	Agricultural Nonpoint Source Reduction Strategies
BOR	WaterSMART	The Bureau of Reclamation administers funding for water conservation projects that promote agricultural efficiencies as well as implementation of nature-based solutions for environmental benefits.	Agricultural Practices & Management. Pollution Control
UDAF	Agricultural Voluntary Incentive Program (Ag VIP)	The Agriculture Voluntary Incentive Program (AgVIP) implements practices that can increase crop yields, improve soil health, and add value to operations, while improving water quality.	Agricultural Nonpoint Source Reduction Strategies
UDAF	Utah Grazing Improvement Program	The Utah Grazing Improvement Program seeks to improve the productivity, health, and sustainability of rangelands and watersheds. The UGIP Small Livestock Producers Grant is open to small livestock producers (50 animal units or less) for projects that will improve grazing management on federal, state, or private land.	Agricultural Nonpoint Source Reduction Strategies

7.5. Evaluation of plan and plan updates

The implementation of the Ogden River Watershed Plan will require continued collaboration among partners engaged with watershed management issues and local landowners including the agricultural community. Progress will be tracked through continued data collection and evaluation, collaboration, and communication among all stakeholders. Continued data collection and PLET model refinements will enable the plan to incorporate new information and help guide management decisions.

Adaptive management is fundamental for the watershed plan. Changes in land cover, habitat conditions, hydrology, population, and management practices will inform plan revisions and assessment of additional actions. Consistent with recommended practices for watershed-based plans, reviewing and updating the plan on a 10-year cycle is recommended. More periodic updates could be incorporated if stakeholders deemed necessary due to changes in regulatory policies, expanded water quality and flow data, innovative management practices, major changes in land use or land cover, updated modeling tools, etc.

Evaluation criteria and metrics

Qualitative and quantitative criteria will be used to track implementation of recommended actions. Metric examples include:

- Seasonal total and filterable nitrogen average concentrations at or below 400ug/L and total and filterable phosphorus average concentrations at or below 35ug/L will be evidence of successful implementation of the plan.
- Comprehensive stream discharge, tributary water quality data, land use/land cover data including adoption of BMPs used to update PLET model and estimate TN and TP loading. A reduction of external loading of 24%, as recommended in the Pineview Reservoir TMDL, will ensure a downward trend in nutrient loading.
- NRCS tracks projects related to BMPs on agricultural lands. Metrics to track progress with voluntary incentive-based practices may include progress towards meeting watershed plan goals. This includes the number of grant awards, number of parcels adopting recommended BMPs, and/or number of collaborators adopting and maintaining BMPs.
- Results of any program with reference/test site, before and after monitoring to evaluate effectiveness of installed BMPs can be used to evaluate trends towards watershed plan goals.
- UDOT and partners reports related to streambank stabilization and road and ditch improvements. Annual reports can be a source of data and information to gauge trends towards watershed plan goals.
- Weber-Morgan County health department oversees installation of new and modified septic systems. Their input can inform wastewater infrastructure issues. Quantitative metrics can include the number of failing systems and the number of septic systems replaced. PLET can be used to estimate nitrogen and phosphorus load reductions associated with septic system upgrades, relocation, and/or replacement.

- Continue to map the extent of watershed lands under conservation easements with input from land trusts.
- Track outreach and education initiatives to incorporate watershed health, protection of water resources, behavior, and increased awareness of issues that affect water quality.

8. Monitoring

Both quantitative and qualitative metrics will be used to track implementation of the recommended actions, and the extent to which waterbodies in the Ogden River Watershed support their best uses for drinking, fishing, irrigation, stock watering, and supporting aquatic wildlife.

The UDWQ routinely monitors streams and lakes through Utah's Water Quality Monitoring program to track long-term water quality trends and ensure their designated uses are being supported. The WRP will rely on monitoring currently being completed by the UDWQ for long-term trends and to evaluate project and program effectiveness and progress towards water quality goals. Monitoring by UDWQ can be augmented by volunteer efforts (e.g., Utah Water Watch Monitoring Program) with additional stream water monitoring completed on a rotating cyclic basis that moves monitoring sites around from year to year focusing on different targeted subwatersheds.

The WRP and partners will review monitoring data annually with trend analysis of the data completed once every five to ten years. Monitoring results will be reviewed annually and reported in WRP's annual report and newsletter. Further water quality data collection and monitoring will help inform the overall effectiveness of this plan and implementation efforts.

Water quality monitoring is conducted by various agencies and organizations at various spatial and temporal scales. The following text describes the primary monitoring efforts and metrics. Secondary metrics will be identified according to measures or practices selected for implementation; examples are provided above in Section 7.5.

Primary Metrics

- Annual monitoring reports from UDWQ to evaluate water quality standards related to aquatic habitat. Seasonal total and filterable nitrogen concentration <400 ug/L and total phosphorus and filterable phosphorus concentrations <35 ug/L will be evidence of successful implementation of the 9E Plan.
- Stream discharge, meteorological data, tributary water quality data, septic system data, number of animals, and land use/land cover data including adoption of BMPs will be used to update the PLET model and estimate external nitrogen, phosphorus, and sediment loading. Reduction in external loading of 24% as determined through continued evaluation and application of the PLET model framework and/or other tools will be evidence of progress towards successful implementation of the 9E Plan.

References

Combe, K. (2023, 5 4). Personal Communication.

Dewitz, J. a. (2021). National Land Cover Database (NLCD) 2019 Products (ver. 2.0, June 2021): U.S. Geological Survey data release. U.S. Geological Survey.

Helsel, D. R. (2012). Statistics for Censored Environmental Data Using Minitab and R Second Edition. Hoboken, NJ: John Wiley & Sons, Inc.

Jordan, J. L., Smith, S. D., Inkenbrandt, P. C., Lowe, M., Hardwick, C. L., Wallace, J., Payne, E. E. (2019). Characterization of the Groundwater System in Ogden Valley, Weber County, Utah, with Emphasis on Groundwater-Surface-Water Interaction and the Groundwater Budget. Utah Department of Natural Resources. Salt Lake City, UT: Utah Geological Survey.

Jordan, L. (2023, 04 19). Personal Communication.

Laflen, J. M. (2013). The development of U. S. soil erosion prediction and modeling. International Soil and Water Conservation Research, 1:1–11.

Lee, L. (2020, March 22). Package 'NADA'. USGS.

McBride, J. (2023, 06 21). Personal communication.

Montana DEQ and EPA Region 8. (2014). Upland Erosion Sediment Assessment (Appendix C) in Kootenai-Fisher Project Area Metals, Nutrients, Sediment, and Temperature TMDLs and Water Quality Improvement Plan. Helena, MT: Montana Dept. of Environmental Quality.

Panagos, P. P. (2015). New European Slope Length and Steepness Factor (LS-Factor) for Modeling Soil Erosion by Water. GEOSCIENCES, 5:117–126.

Renard, K. G. (1997). Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). Agricultural Handbook No.703. Washington DC: U. S. Dept. of Agriculture.

Tetra Tech, Inc. (2002). Pineview Reservoir TMDL. Tetra Tech, Inc.

Tetra Tech, Inc. (March 2022). User's Guide Pollution Load Estimation Tool (PLET) Version 1.0. Fairfax, VA: Tetra Tech, Inc.

UDWQ. (2019). Numeric nitrogen and phosphorus criteria: Utah headwater streams. Utah Division of Water Quality. Salt Lake City.

UDWQ. (2021). Utah's combined 2018/2020 integrated report. . Salt Lake City: Utah Department of Environmental Quality.

UDWQ. (2022). Final 2022 Integrated Report on Water Quality. Salt lake City: Utah Department of Environmental Quality Division of Water Quality.

United States Census Bureau. (2023, June 26). Retrieved from QuickFacts Weber County, Utah: https://www.census.gov/quickfacts/webercountyutah

USEPA. (2008). Handbook for developing watershed plans to restore and protect our waters. Washington, DC: U.S. Environmental Protection Agency.

USEPA. (2013, April 12). Nonpoint source program and grants guidelines for states and territories. Washington , DC, USA.

WBWCD. (2018). 2018 Conservation Plan Update. Layton: Weber Basin Water Conservancy District.

[Page Intentionally Left Blank]

APPENDIX I

SUMMARY OF NUTRIENT CHARACTERISTICS DATA USED FOR BOXPLOTS . < IS CENSORED VALUE, <= INDICATES CENSORING LEVEL ABOVE REPORTED VALUE.

Site	Result Count	Censored Result Count	Date First Result	Date Last Result	Result Minimum	Result Maximum	Result Median
AMMONIA-NITROGEN DISSOLVED AS N in UG/L							
Ogden Confluence	2	2	10/24/2022	10/27/2022	<50	<50	<50
Warren abv WWTP	2	2	10/24/2022	10/27/2022	<50	<50	<50
AMMONIA-NITROGEN TOTAL AS N in UG/L							
Ogden Confluence	89	74	1/18/1983	10/27/2022	<20	200	<20
Ogden Wall Ave	24	24	10/26/2015	9/13/2022	<20	<50	<50
Ogden Monroe	1	1	9/11/2013	9/11/2013	<46	<46	<46
Ogden at Canyon Mouth	147	106	2/4/1976	9/14/2022	<20	1848	<20
Ogden at Canyon Mouth Rep	24	24	10/27/2015	9/14/2022	<20	<50	<50
Ogden abv Canyon Mouth	1	1	9/9/2013	9/9/2013	<46	<46	<46
Wheeler abv E. Fk	2	2	7/2/2013	7/18/2016	<46	<50	<50
Wheeler abv Ogden	103	98	10/21/1976	9/14/2022	<20	109	<20
NF Upper	2	2	7/22/2013	7/18/2016	<46	<50	<50
NF Ogden Lower	79	77	10/21/1976	6/29/2022	<20	100	<20
MF Ogden	60	56	10/21/1976	8/2/2022	<20	100	<20
SF Ogden	90	80	10/21/1976	9/14/2022	<20	500	<20
Warren abv WWTP	2	1	10/24/2022	10/27/2022	<=19	19	<=19
KJELDAHL NITROGEN TOTAL NA in UG/L							
Ogden Confluence	4	0	1/18/1983	5/11/1983	400	800	
Ogden at Canyon Mouth	40	0	2/2/1976	5/14/1997	100	1600	
Wheeler abv Ogden	2	0	10/21/1994	6/4/1997	100	811	455.5
NF Ogden Lower	1	0	6/3/1980	6/3/1980	400	400	400
MF Ogden	3	0	4/18/1978	6/3/1980	100	400	300
SF Ogden	2	0	6/3/1980	8/21/1980	400	500	450
NITRATE + NITRITE DISSOLVED AS N in UG/L							
Ogden Confluence	14	0	10/18/2021	10/27/2022	29	305	124.5
Ogden Wall Ave	12	0	10/18/2021	9/13/2022	32	438	207
Ogden at Canyon Mouth	12	0	10/18/2021	9/14/2022	54	434	217
Ogden at Canyon Mouth Rep	12	0	10/18/2021	9/14/2022	52	432	213
Wheeler abv Ogden	11	0	10/19/2021	9/14/2022	52	404	264

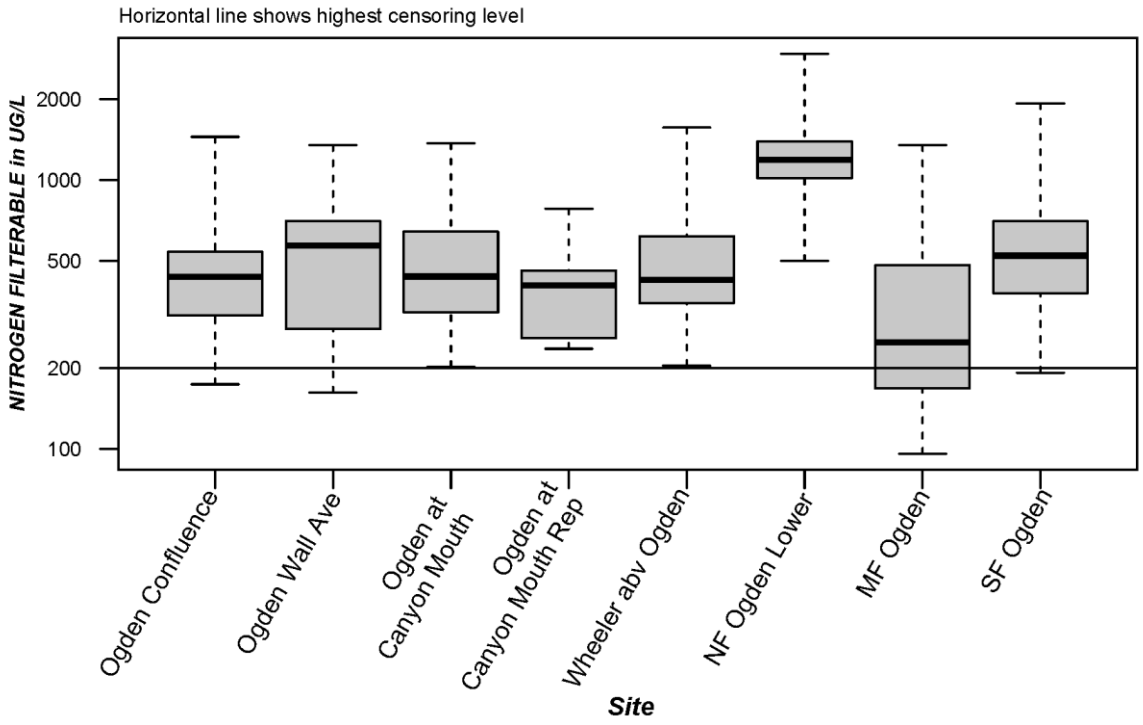
Site	Result Count	Censored Result Count	Date First Result	Date Last Result	Result Minimum	Result Maximum	Result Median
NF Ogden Lower	5	0	2/8/2022	6/29/2022	939	1940	1210
MF Ogden	10	5	11/16/2021	8/2/2022	<=25	111	35.65
SF Ogden	12	0	10/19/2021	9/14/2022	113	928	301.5
Warren abv WWTP	2	0	10/24/2022	10/27/2022	465	532	498.5
NITRATE + NITRITE TOTAL AS N in UG/L							
Ogden Confluence	33	1	1/18/1983	10/27/2022	<=26	841	128
Ogden Wall Ave	24	2	10/26/2015	9/13/2022	<=30	429	160.5
Ogden at Canyon Mouth	120	12	1/25/1978	9/14/2022	<=17	867	170
Ogden at Canyon Mouth Rep	24	0	10/27/2015	9/14/2022	20	432	142.5
Wheeler abv E. Fk	1	0	7/18/2016	7/18/2016	296	296	296
Wheeler abv Ogden	116	14	4/18/1978	9/14/2022	<=13.7	940	150
NF Upper	1	0	7/18/2016	7/18/2016	88	88	88
NF Ogden Lower	46	1	1/17/1978	6/29/2022	<50	1900	700
MF Ogden	52	17	4/18/1978	8/2/2022	<=16.8	450	52
SF Ogden	59	1	1/17/1978	9/14/2022	<50	1500	350
Warren abv WWTP	2	0	10/24/2022	10/27/2022	448	522	485
NITRATE + NITRITE TOTAL AS NO3 in UG/L							
Pineview Outflow	2	0	9/22/2016	9/22/2016	100	100	100
NF Ogden at Lamondi	2	0	9/20/2016	9/20/2016	100	100	100
NF Trib Liberty	2	0	9/22/2016	9/22/2016	604	604	604
MF Ogden Upper	2	0	9/20/2016	9/20/2016	100	100	100
NITRATE TOTAL AS NO3 in UG/L							
Ogden at Canyon Mouth	59	0	2/2/1976	11/28/1983	20	1310	400
Wheeler abv Ogden	64	1	10/8/1975	11/28/1983	<=20	1310	200
NF Ogden Lower	53	0	10/8/1975	8/28/1980	100	1250	550
MF Ogden	66	1	2/9/1975	11/28/1983	<=20	1300	175
SF Ogden	53	0	10/8/1975	9/4/1980	50	1100	200
NITRITE TOTAL AS NO2 in UG/L							
Ogden at Canyon Mouth	40	18	1/6/1977	11/28/1983	<10	80	20
Wheeler abv Ogden	38	19	6/8/1978	11/28/1983	<10	220	10
NF Ogden Lower	7	6	6/8/1978	8/28/1980	<50	50	50
MF Ogden	37	21	8/21/1979	11/28/1983	<10	70	10
SF Ogden	9	7	6/9/1977	9/4/1980	<50	50	50
NITROGEN FILTERABLE AS N in UG/L							
Ogden Confluence	21	0	1/21/2009	10/27/2022	174	1450	437
Ogden Wall Ave	12	0	10/18/2021	9/13/2022	162	1350	571
Ogden Monroe	1	0	9/11/2013	9/11/2013	352	352	352

Site	Result Count	Censored Result Count	Date First Result	Date Last Result	Result Minimum	Result Maximum	Result Median
Ogden at Canyon Mouth	19	0	1/21/2009	9/14/2022	202	1370	438
Ogden at Canyon Mouth Rep	12	0	10/18/2021	9/14/2022	236	783	405.5
Ogden abv Canyon Mouth	1	0	9/9/2013	9/9/2013	417	417	417
Wheeler abv E. Fk	1	0	7/2/2013	7/2/2013	392	392	392
Wheeler abv Ogden	18	0	1/21/2009	9/14/2022	204	1570	425.5
NF Upper	1	0	7/22/2013	7/22/2013	452	452	452
NF Ogden Lower	15	0	1/21/2009	6/29/2022	501	2950	1190
MF Ogden	22	3	1/21/2009	8/2/2022	<=98	1350	249
SF Ogden	24	0	1/21/2009	9/14/2022	192	1930	524
Warren abv WWTP	2	0	10/24/2022	10/27/2022	540	615	577.5
NITROGEN TOTAL AS N in UG/L							
Ogden Confluence	26	0	10/26/2015	10/27/2022	164	587	334.5
Ogden Wall Ave	24	0	10/26/2015	9/13/2022	179	642	349
Ogden at Canyon Mouth	24	0	10/27/2015	9/14/2022	213	952	295
Ogden at Canyon Mouth Rep	24	0	10/27/2015	9/14/2022	185	883	322
Wheeler abv E. Fk	1	0	7/18/2016	7/18/2016	431	431	431
Wheeler abv Ogden	23	0	10/27/2015	9/14/2022	186	636	327
NF Upper	1	0	7/18/2016	7/18/2016	237	237	237
NF Ogden Lower	13	0	11/17/2015	6/29/2022	649	2050	1100
MF Ogden	23	0	10/27/2015	8/2/2022	91	598	216
SF Ogden	26	0	10/27/2015	9/14/2022	182	1040	514
Warren abv WWTP	2	0	10/24/2022	10/27/2022	583	608	595.5
ORGANIC NITROGEN DISSOLVED NA in UG/L							
Ogden Confluence	7	0	7/15/2008	2/23/2009	222	2520	387
Ogden at Canyon Mouth	7	0	7/15/2008	2/23/2009	206	1030	626
Wheeler abv Ogden	7	0	7/15/2008	2/23/2009	200	1550	323
NF Ogden Lower	8	0	7/15/2008	2/23/2009	523	1420	680
MF Ogden	5	4	9/8/2008	2/23/2009	<200	510	510
SF Ogden	8	0	7/15/2008	2/23/2009	258	960	654.5
ORTHOPHOSPHATE DISSOLVED AS P in UG/L							
Ogden Confluence	2	0	10/24/2022	10/27/2022	21.9	22.2	22.05
Warren abv WWTP	2	0	10/24/2022	10/27/2022	37.2	38.4	37.8
ORTHOPHOSPHATE TOTAL AS P in UG/L							
Ogden at Canyon Mouth	45	4	2/4/1976	10/24/1983	<20	1800	180
Pineview Outflow	1	0	9/22/2016	9/22/2016	15.9	15.9	15.9
Wheeler abv Ogden	47	7	6/3/1976	10/24/1983	<=10	2200	150

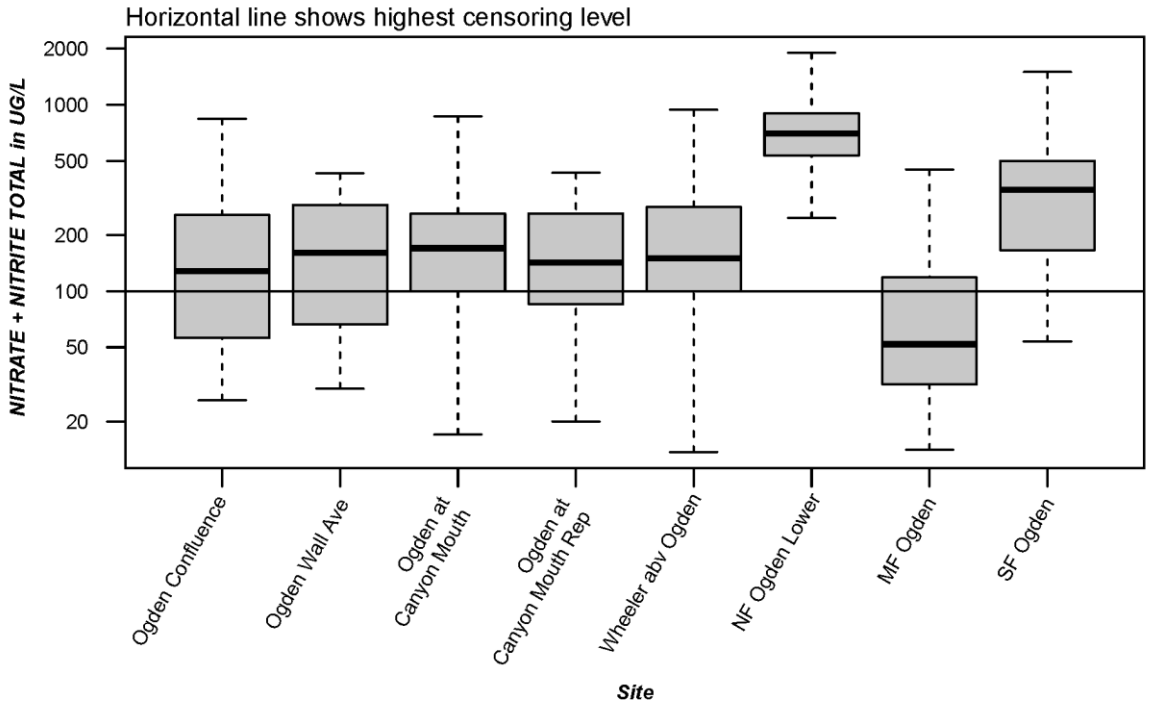
Site	Result Count	Censored Result Count	Date First Result	Date Last Result	Result Minimum	Result Maximum	Result Median
NF Ogden at Lamondi	1	0	9/20/2016	9/20/2016	13	13	13
NF Trib Liberty	1	0	9/22/2016	9/22/2016	16	16	16
NF Ogden Lower	22	7	6/3/1976	8/28/1980	<=10	540	20
MF Ogden Upper	1	0	9/20/2016	9/20/2016	7	7	7
MF Ogden	47	9	10/8/1975	10/24/1983	<=10	2300	150
SF Ogden	24	7	10/8/1975	9/4/1980	<=10	110	20
TOTAL PHOSPHORUS, MIXED FORMS DISSOLVED AS P in UG/L							
Ogden Confluence	14	0	10/18/2021	10/27/2022	6	34	9.85
Ogden Wall Ave	12	0	10/18/2021	9/13/2022	4.5	16.8	8.65
Ogden at Canyon Mouth	12	0	10/18/2021	9/14/2022	3.6	14.1	5.75
Ogden at Canyon Mouth Rep	12	0	10/18/2021	9/14/2022	4.5	15.4	6
Wheeler abv Ogden	11	0	10/19/2021	9/14/2022	4.7	14.4	5.3
NF Ogden Lower	5	0	2/8/2022	6/29/2022	3.4	5.5	5.3
MF Ogden	10	0	11/16/2021	8/2/2022	3.5	11.9	6.7
SF Ogden	12	0	10/19/2021	9/14/2022	5.7	17.1	10.2
Warren abv WWTP	2	0	10/24/2022	10/27/2022	14.1	15.5	14.8
TOTAL PHOSPHORUS, MIXED FORMS TOTAL AS P in UG/L							
Ogden Confluence	14	0	10/18/2021	10/27/2022	13.8	48	15.75
Ogden Wall Ave	12	0	10/18/2021	9/13/2022	10.4	44	21.45
Ogden at Canyon Mouth	12	0	10/18/2021	9/14/2022	5.9	40	14.85
Ogden at Canyon Mouth Rep	12	0	10/18/2021	9/14/2022	6	43	13.7
Wheeler abv Ogden	11	0	10/19/2021	9/14/2022	4.4	53	9.5
NF Ogden Lower	5	0	2/8/2022	6/29/2022	5.9	16.3	10.7
MF Ogden	10	0	11/16/2021	8/2/2022	4.6	37	14.3
SF Ogden	12	0	10/19/2021	9/14/2022	9.4	37	17.1
Warren abv WWTP	2	0	10/24/2022	10/27/2022	34	35	34.5

APPENDIX II

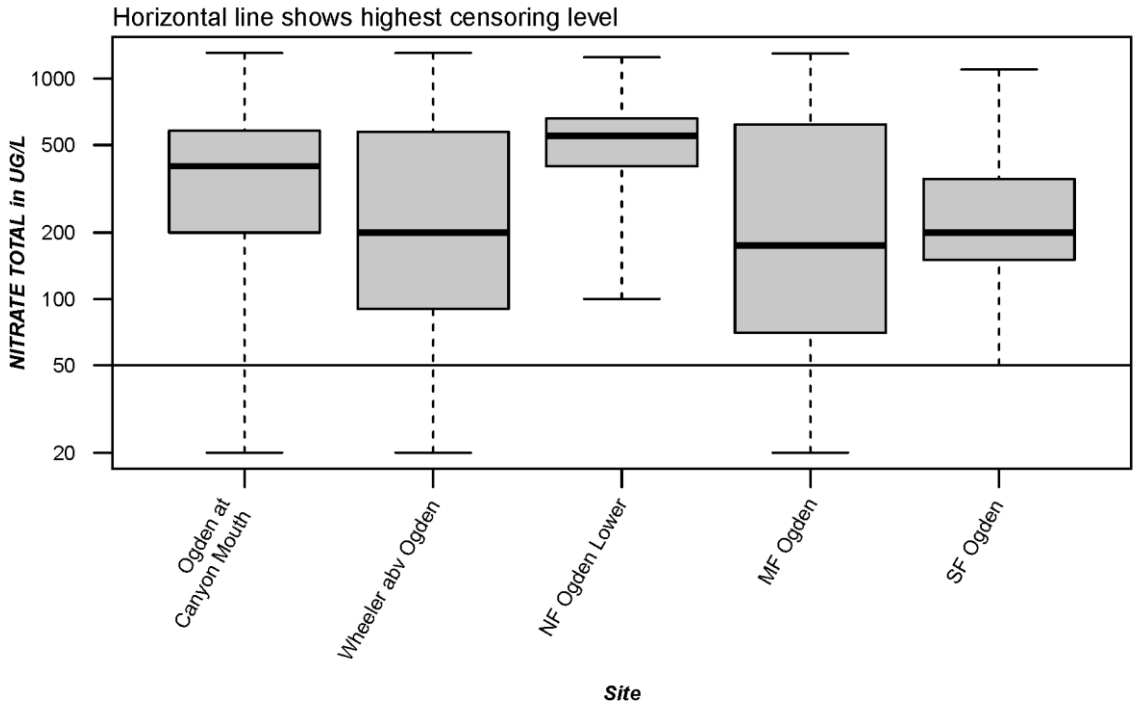
BOXPLOTS OF FOR OTHER NITROGEN AND PHOSPHORUS CHARACTERISTICS BY SITE



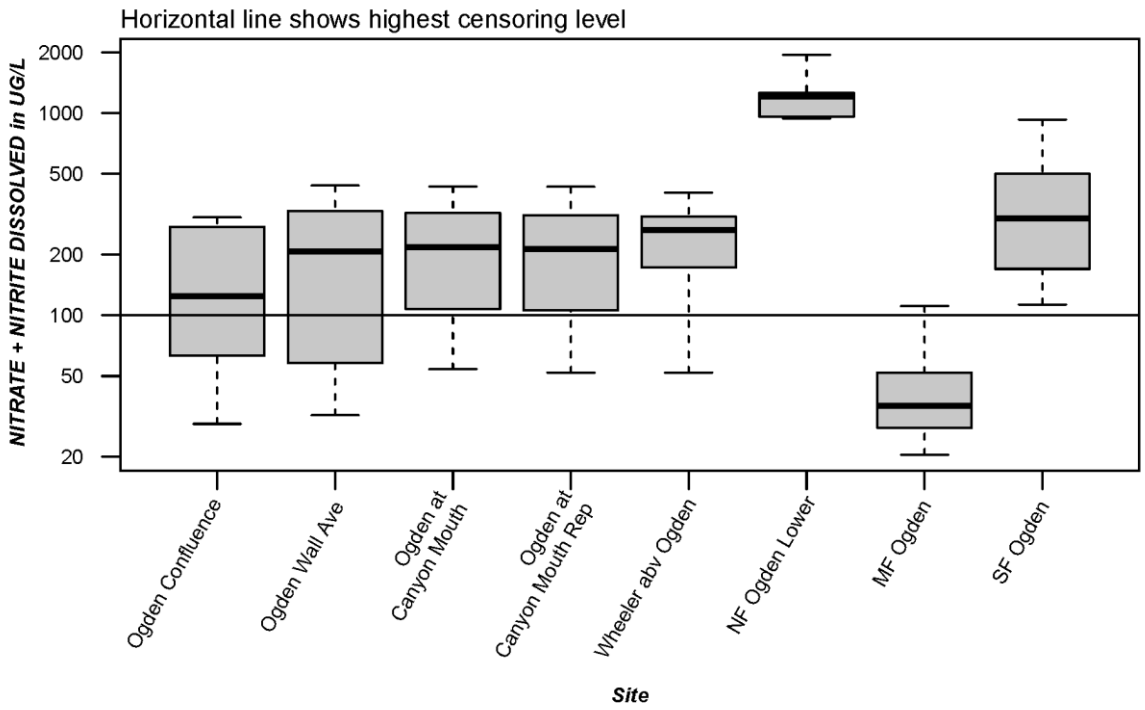
NITROGEN FILTERABLE BOXPLOTS FOR ALL YEARS (BOXPLOTS CREATED USING NADA ROS STATISTICS).



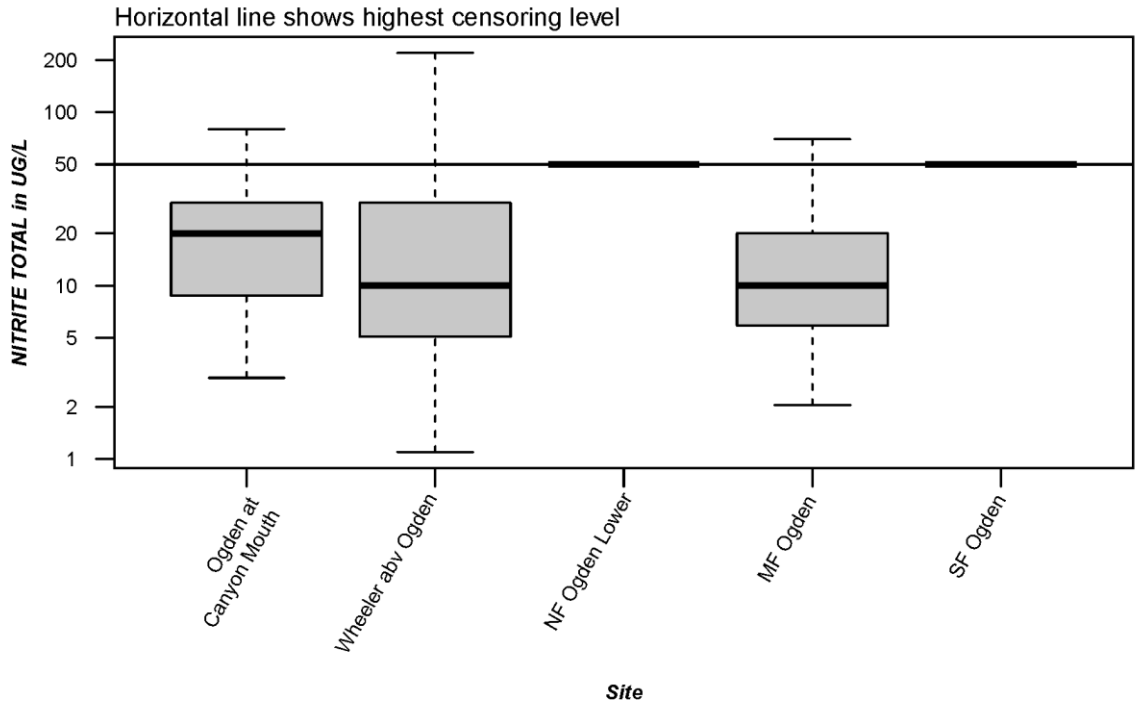
NITRATE + NITRITE TOTAL BOXPLOTS FOR ALL YEARS. BOXPLOTS CREATED USING NADA ROS STATISTICS.



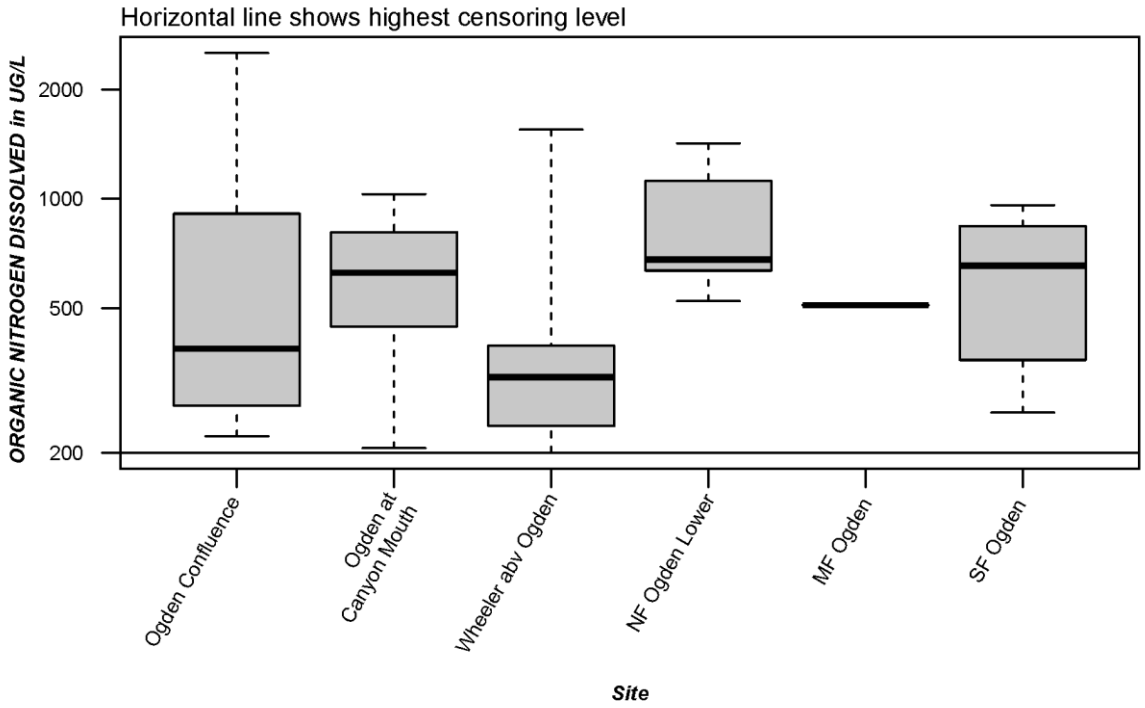
NITRATE TOTAL BOXPLOTS FOR ALL YEARS. BOXPLOTS CREATED USING NADA ROS STATISTICS



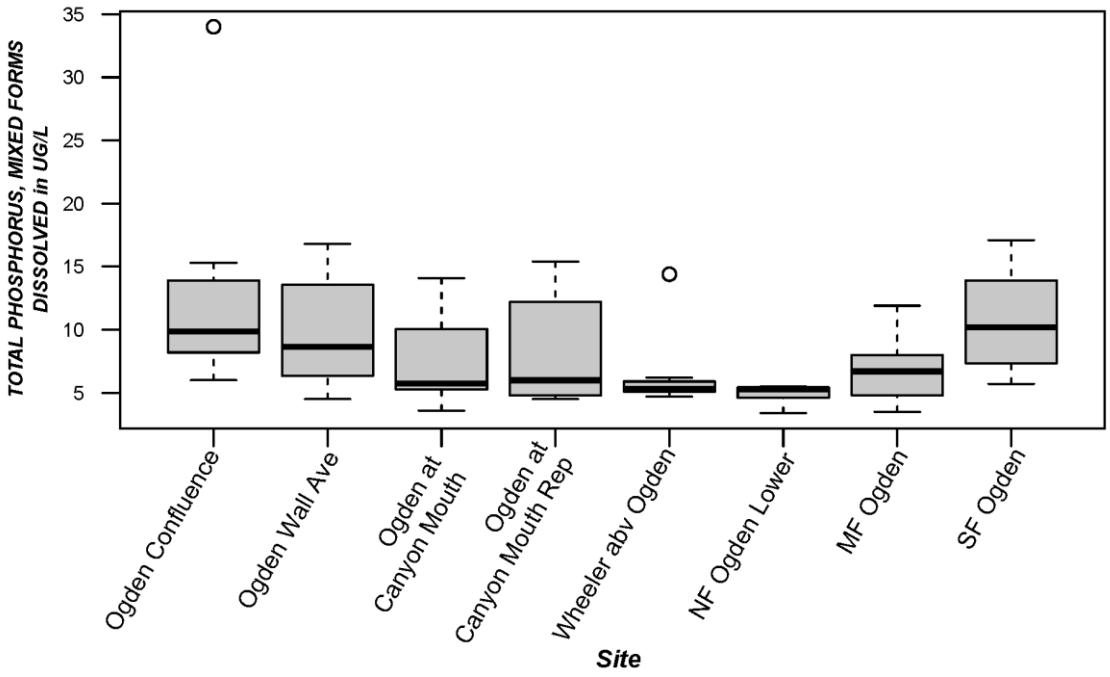
NITRATE + NITRITE DISSOLVED BOXPLOTS FOR ALL YEARS. BOXPLOTS CREATED USING NADA ROS STATISTICS.



NITRITE TOTAL BOXPLOTS FOR ALL YEARS. BOXPLOTS CREATED USING NADA ROS STATISTICS.

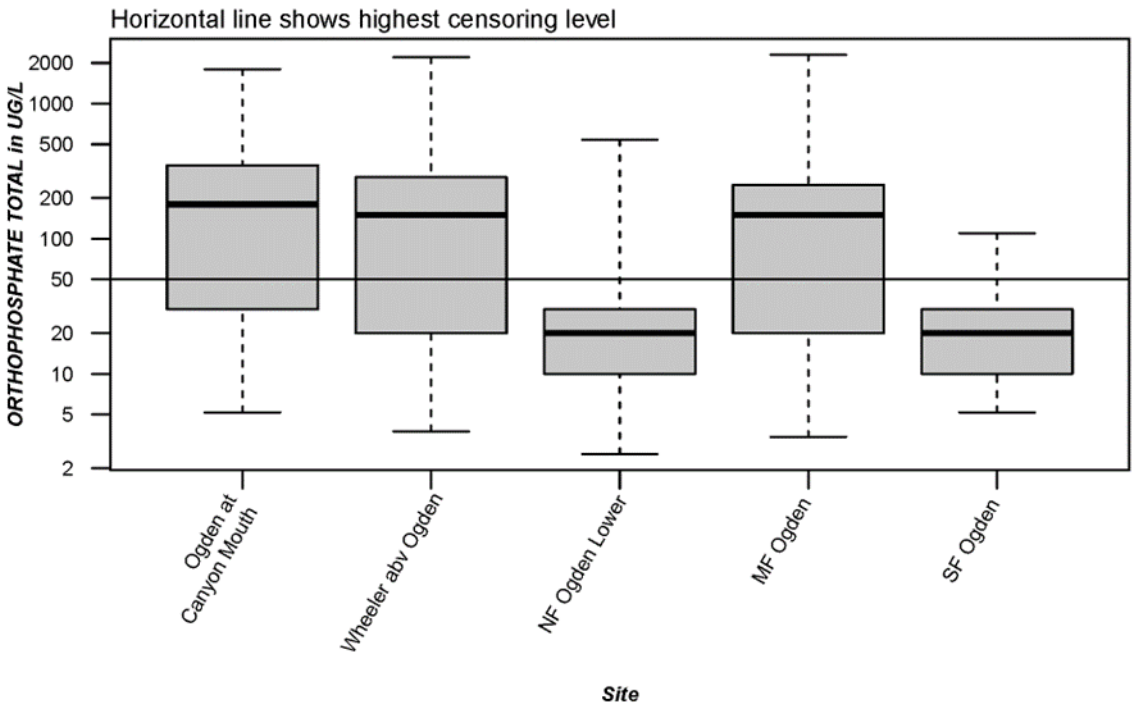


ORGANIC NITROGEN DISSOLVED BOXPLOTS FOR ALL YEARS. BOXPLOTS CREATED USING NADA ROS STATISTIC.



TOTAL PHOSPHORUS DISSOLVED BOXPLOTS FOR ALL YEARS. BOXPLOT CREATED USING NADA CENROS (LEE, 2020).

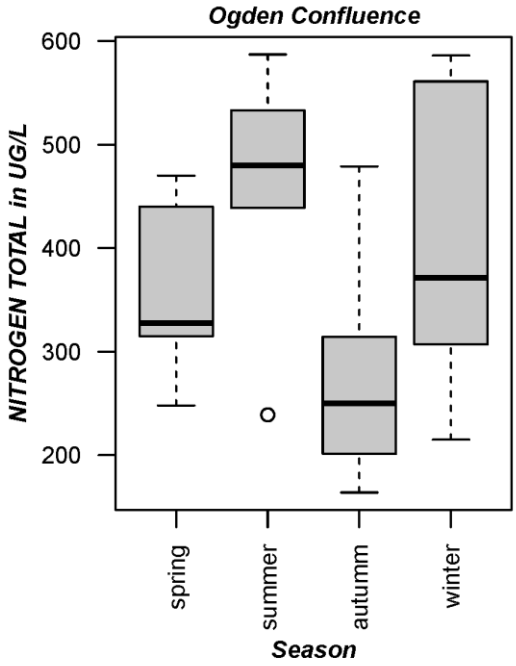
.

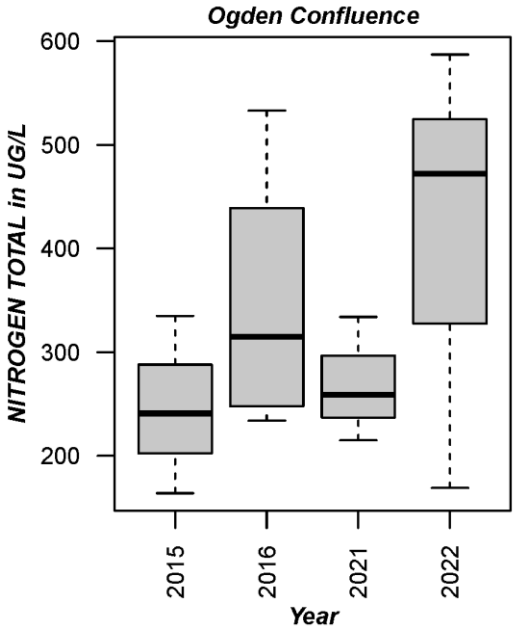


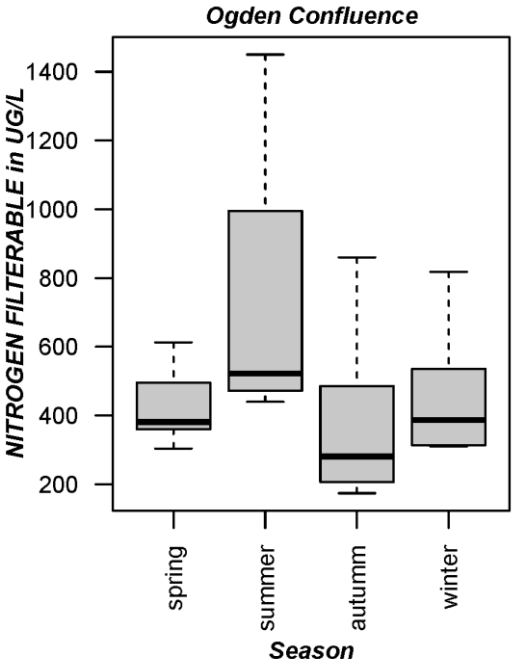
ORTHOPHOSPHATE TOTAL BOXPLOTS FOR ALL YEARS

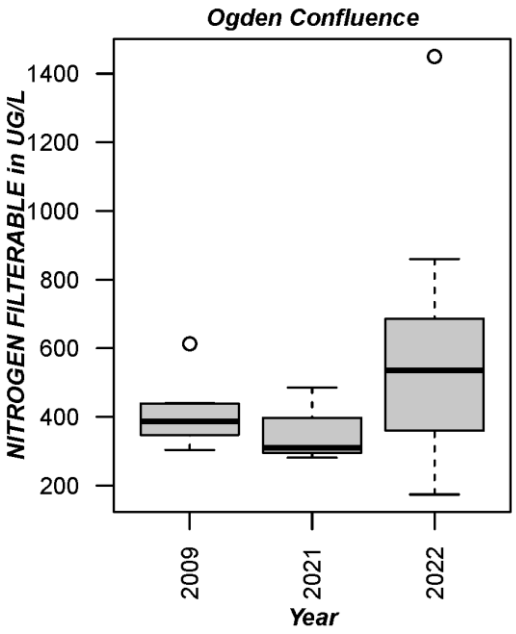
APPENDIX III

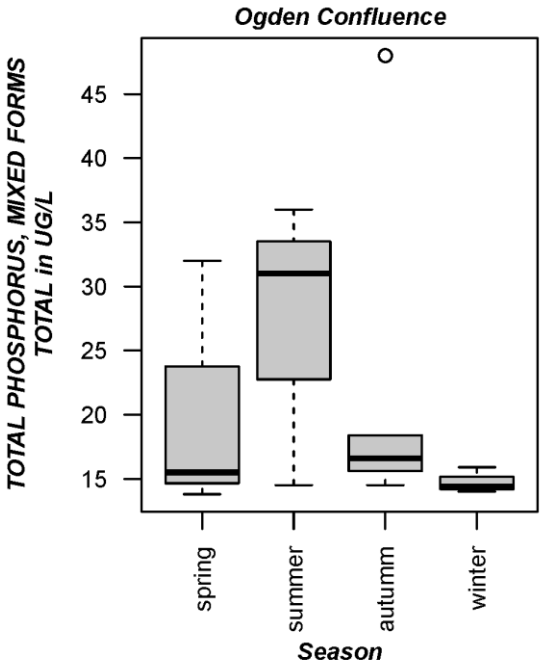
SEASONAL AND ANNUAL BOXPLOTS OF FOR NITROGEN AND PHOSPHORUS CHARACTERISTICS

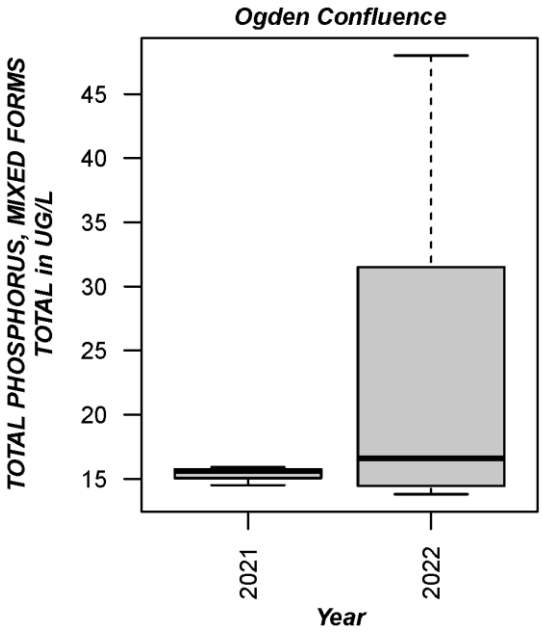


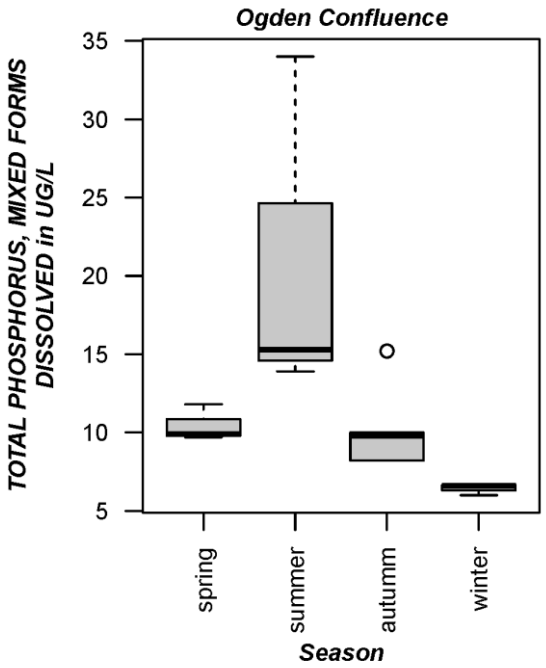


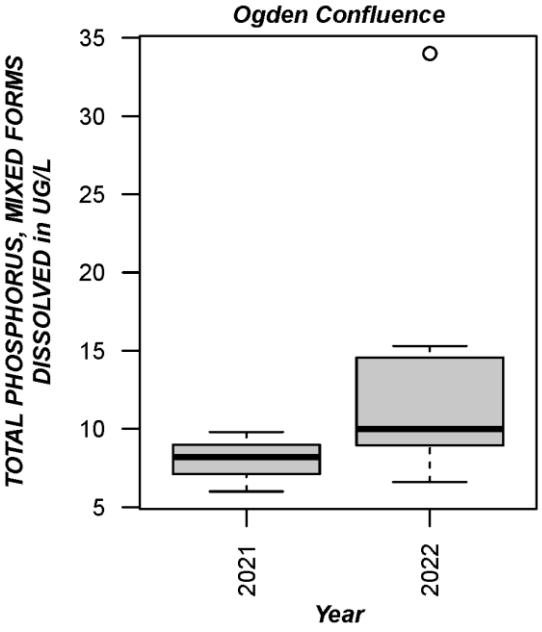


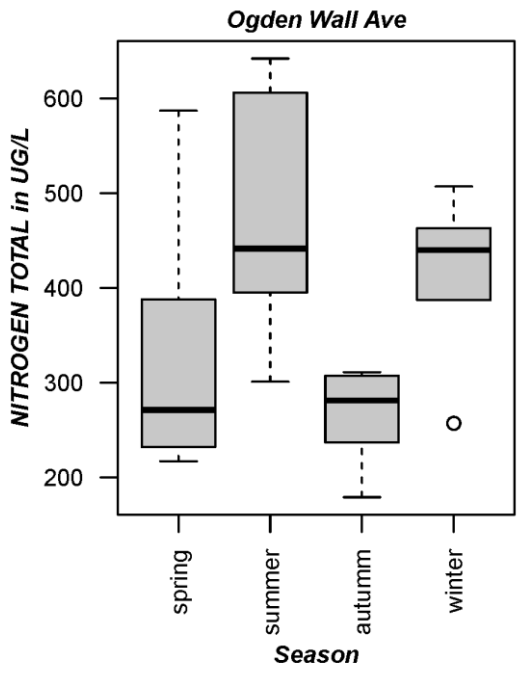


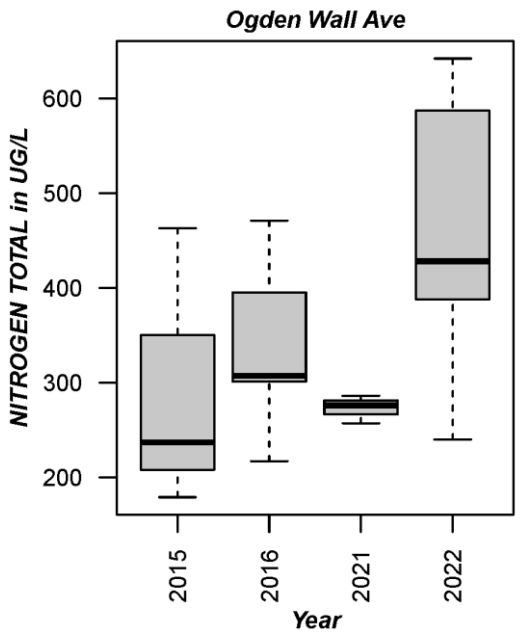

Ogden Confluence
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
45
40
35
30
25
20
15
spring
summer
autumn
winter
Season

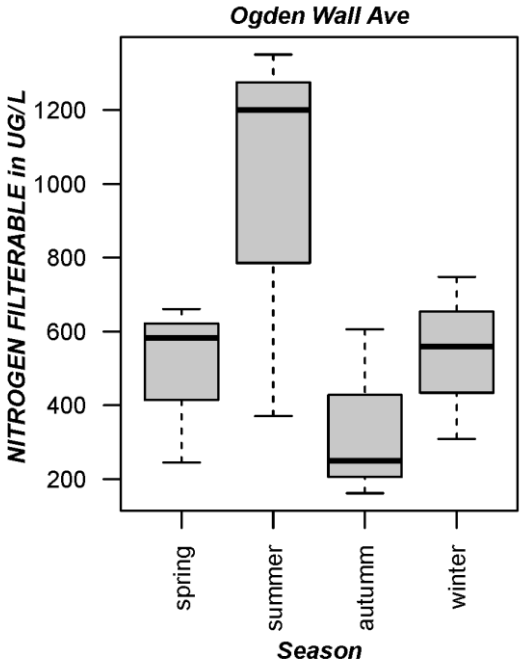

Ogden Confluence
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
45
40
35
30
25
20
15
2021
2022
Year

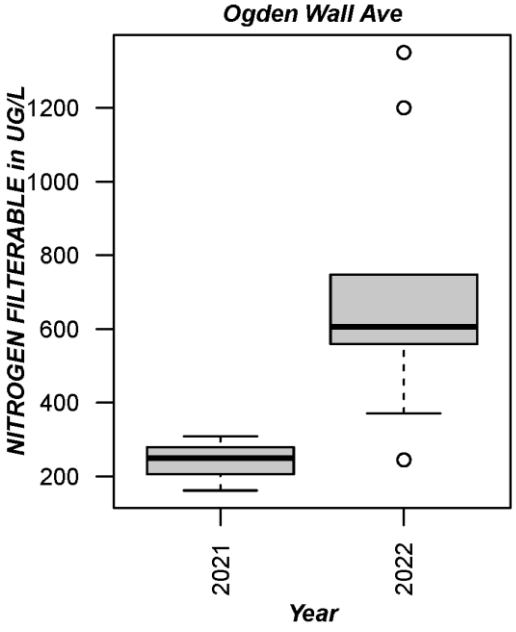

Ogden Confluence
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
35
30
25
20
15
10
5
spring
summer
autumn
winter
Season

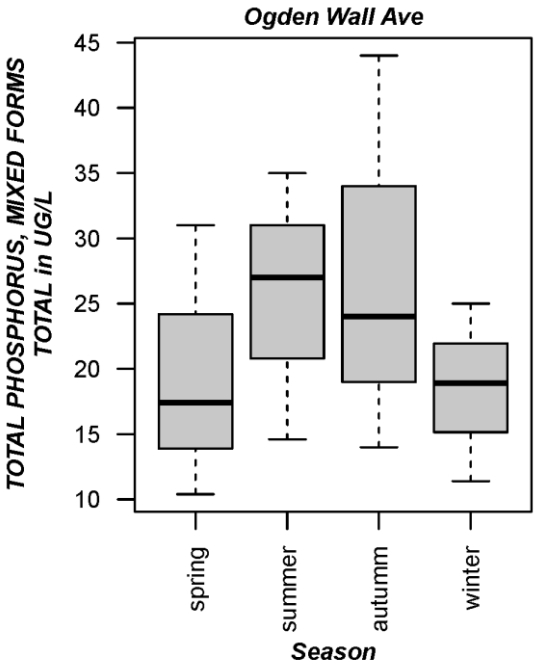

Ogden Confluence
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
35
30
25
20
15
10
5
2021
2022
Year

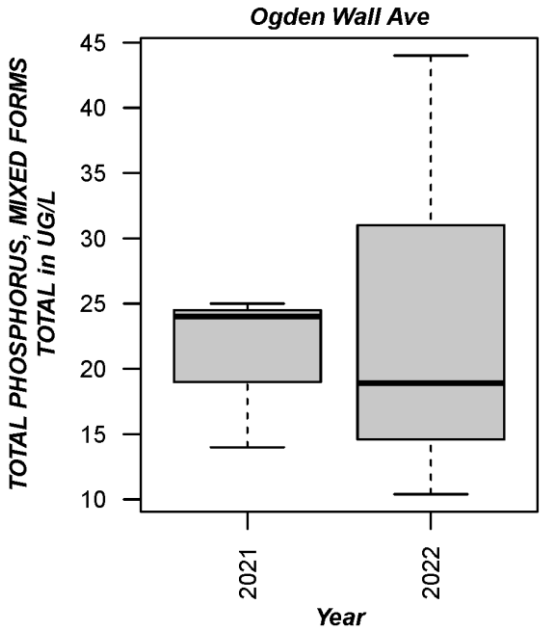

Ogden Wall Ave
NITROGEN TOTAL in UG/L
600
500
400
300
200
spring
summer
autumn
winter
Season

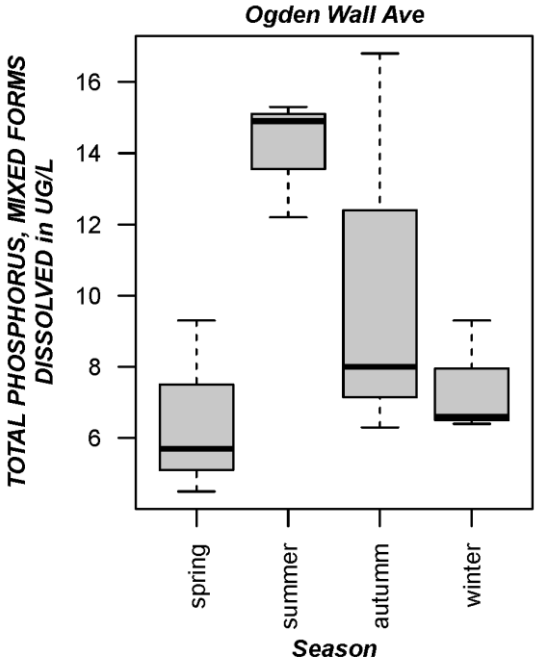

Ogden Wall Ave
NITROGEN TOTAL in UG/L
600
500
400
300
200
2015
2016
2021
2022
Year

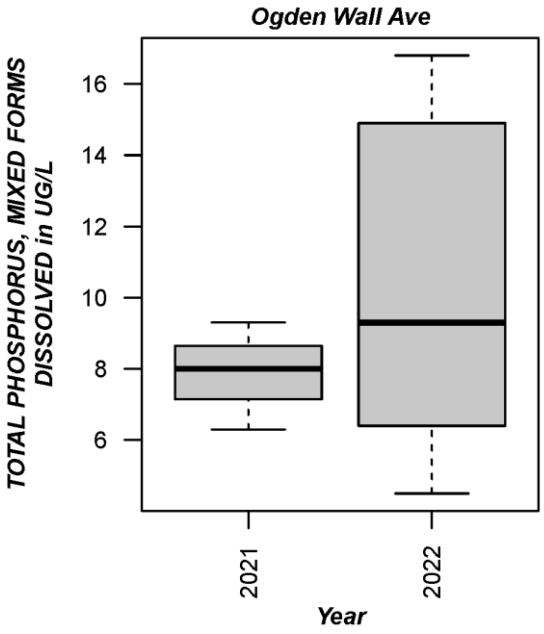

Ogden Wall Ave
NITROGEN FILTERABLE in UG/L
1200
1000
800
600
400
200
spring
summer
autumn
winter
Season

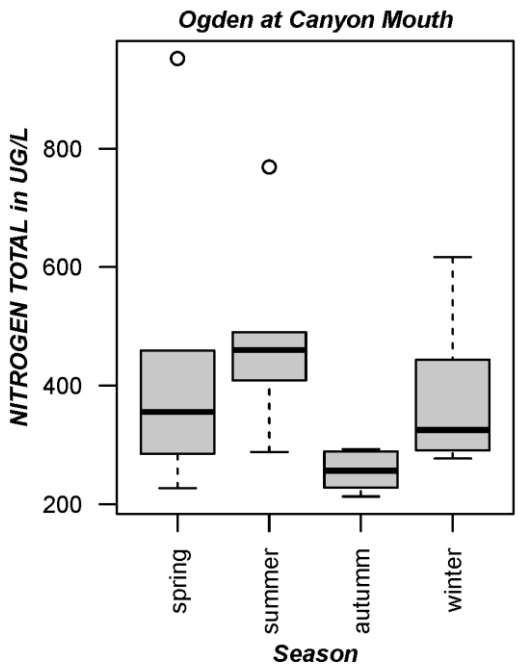

Ogden Wall Ave
NITROGEN FILTERABLE in UG/L
1200
1000
800
600
400
200
2021
2022
Year

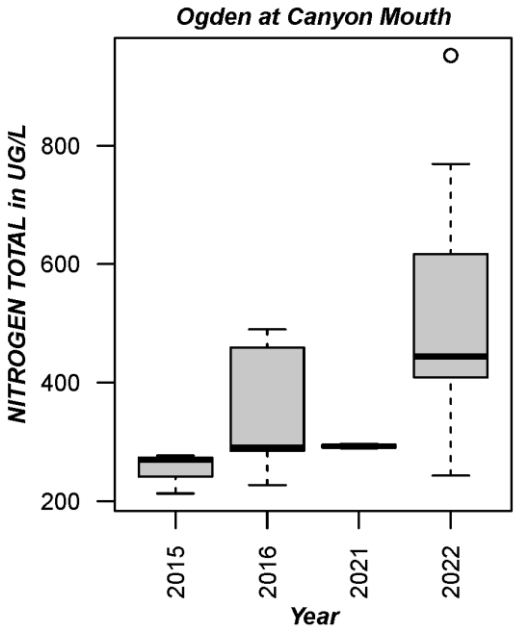

Ogden Wall Ave
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
45
40
35
30
25
20
15
10
spring
summer
autumn
winter
Season

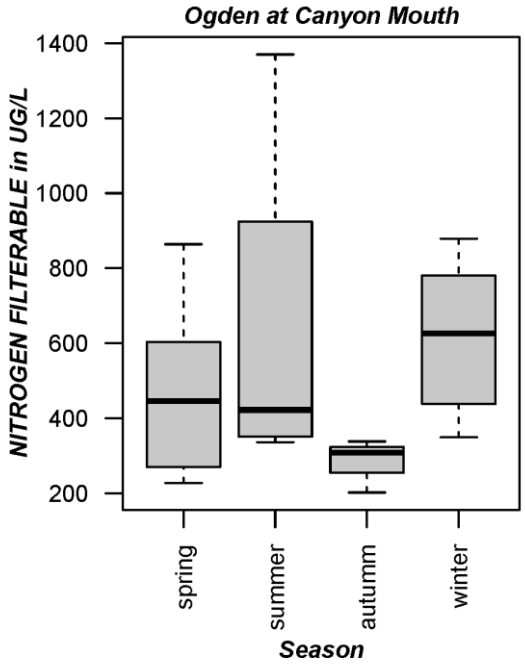

Ogden Wall Ave
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
45
40
35
30
25
20
15
10
2021
2022
Year

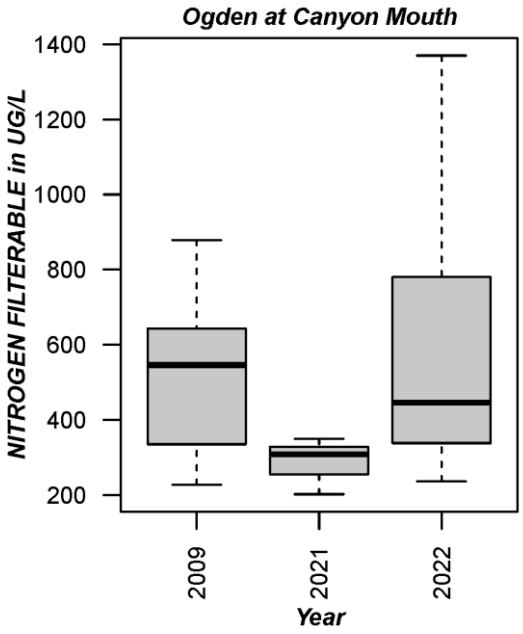

Ogden Wall Ave
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
16
14
12
10
8
6
spring
summer
autumn
winter
Season

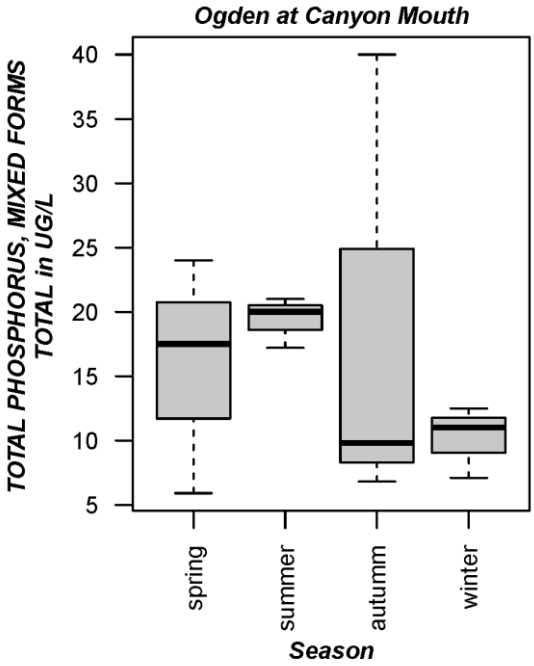

Ogden Wall Ave
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
16
14
12
10
8
6
2021
2022
Year

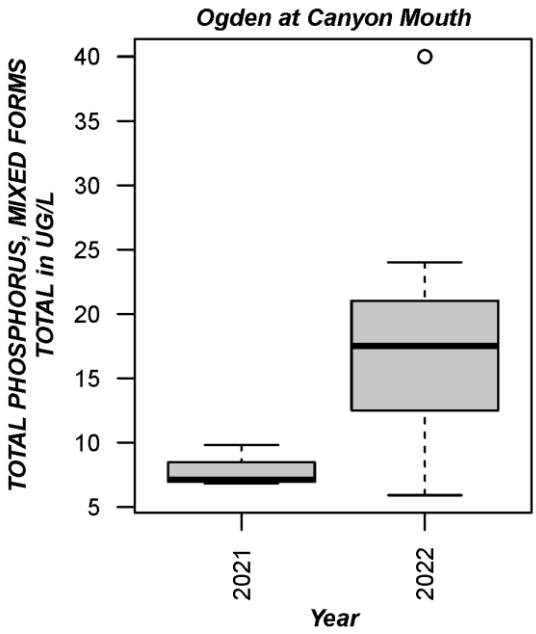

Ogden at Canyon Mouth
NITROGEN TOTAL in UG/L
200
400
600
800
spring
summer
autumn
winter
Season

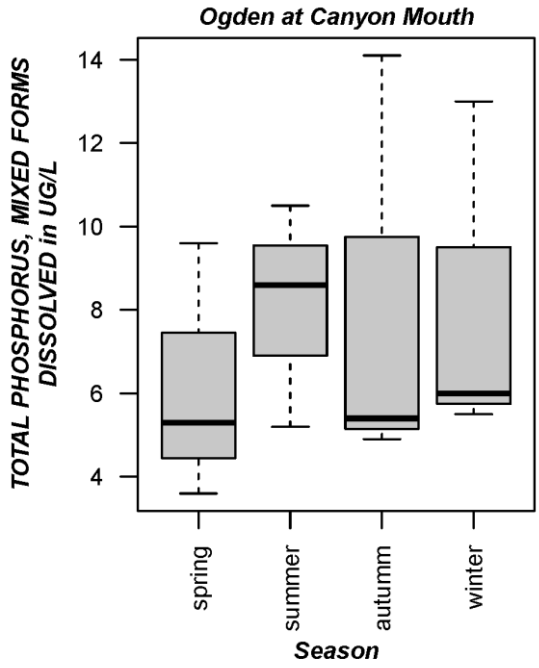

Ogden at Canyon Mouth
NITROGEN TOTAL in UG/L
200
400
600
800
2015
2016
2021
2022
Year

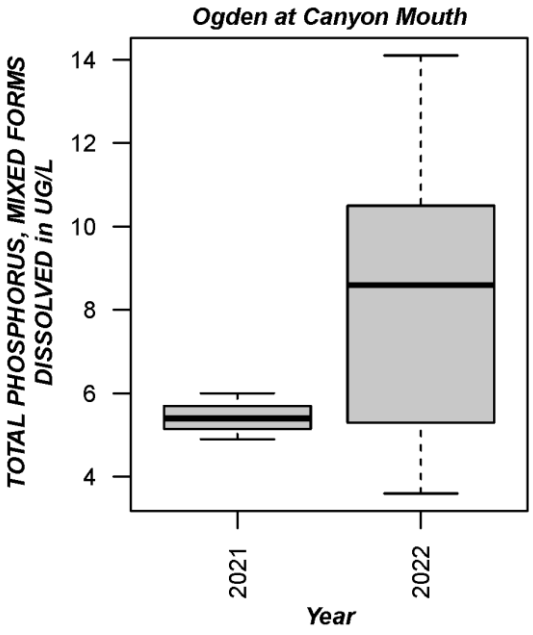

Ogden at Canyon Mouth
NITROGEN FILTERABLE in UG/L
200
400
600
800
1000
1200
1400
spring
summer
autumn
winter
Season

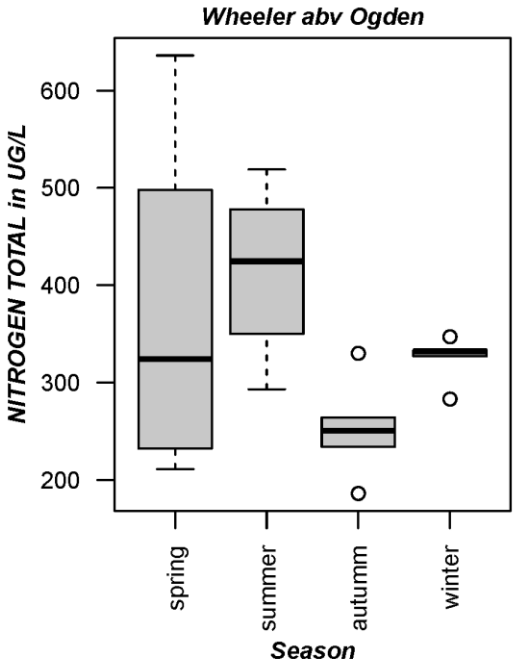

Ogden at Canyon Mouth
NITROGEN FILTERABLE in UG/L
200
400
600
800
1000
1200
1400
2009
2021
2022
Year

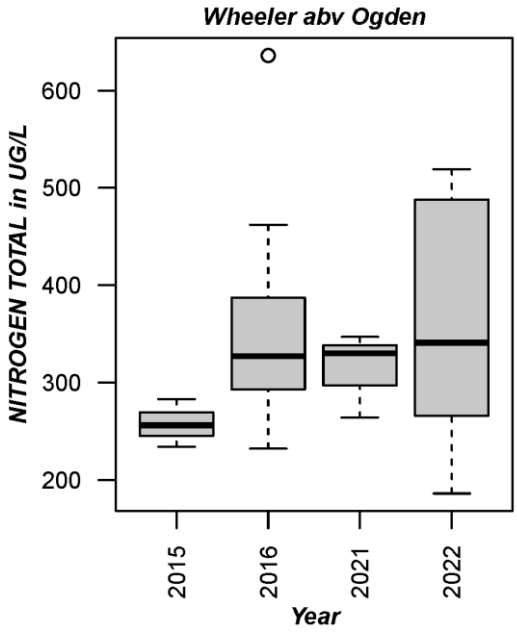

Ogden at Canyon Mouth
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
40
35
30
25
20
15
10
5
spring
summer
autumn
winter
Season

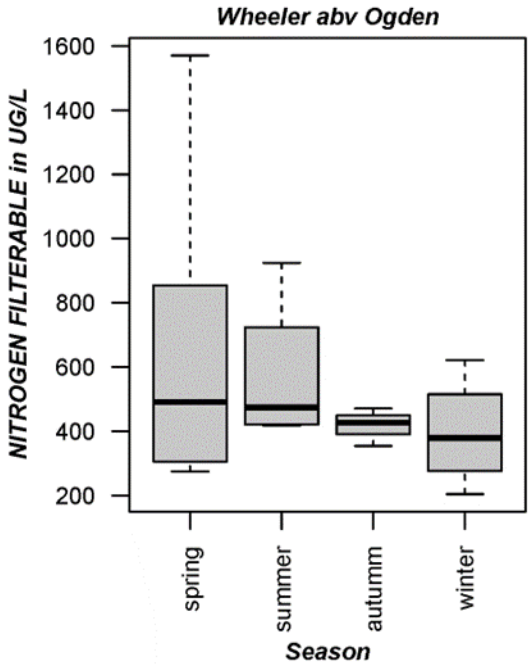

Ogden at Canyon Mouth
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
40
35
30
25
20
15
10
5
2021
2022
Year

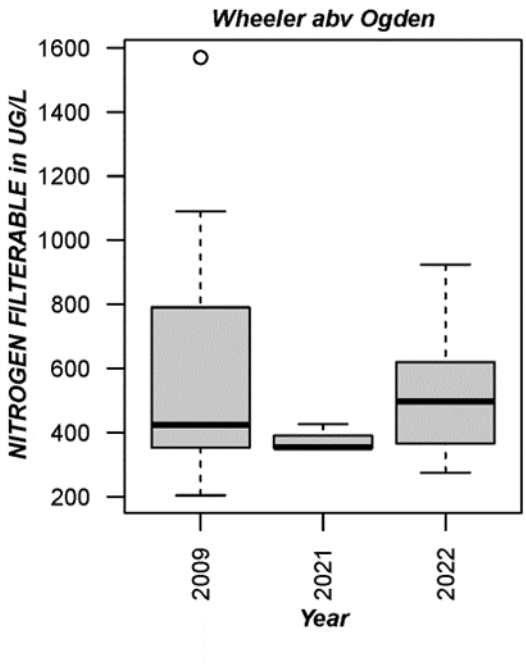

Ogden at Canyon Mouth
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
14
12
10
8
6
4
spring
summer
autumn
winter
Season

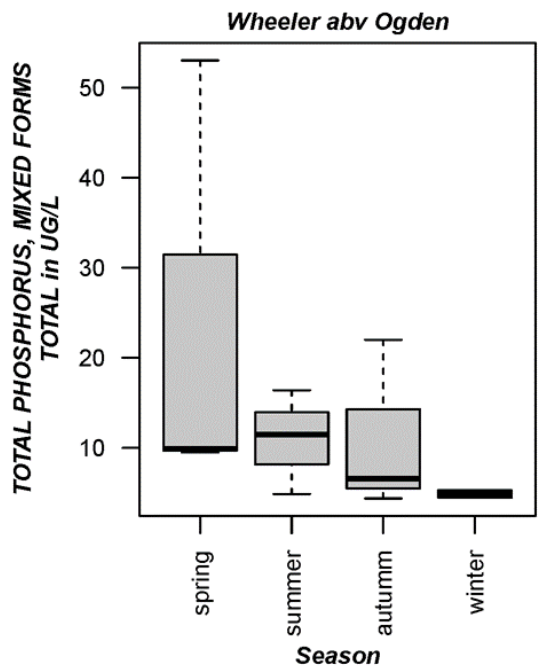

Ogden at Canyon Mouth
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
14
12
10
8
6
4
2021
2022
Year

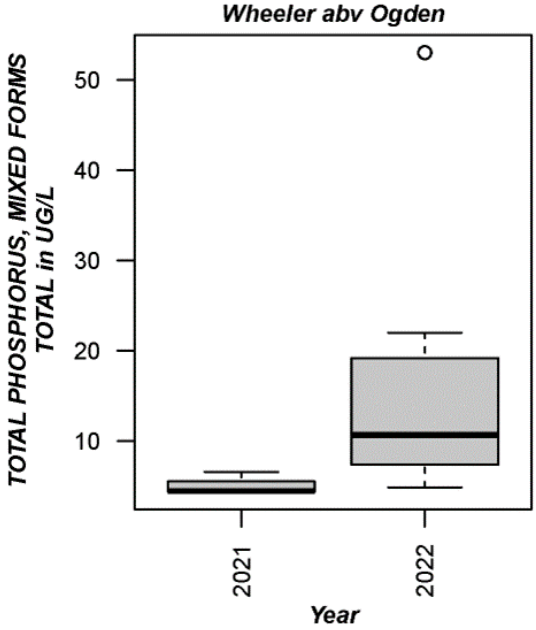

Wheeler abv Ogden
NITROGEN TOTAL in UG/L
600
500
400
300
200
spring
summer
autumn
winter
Season

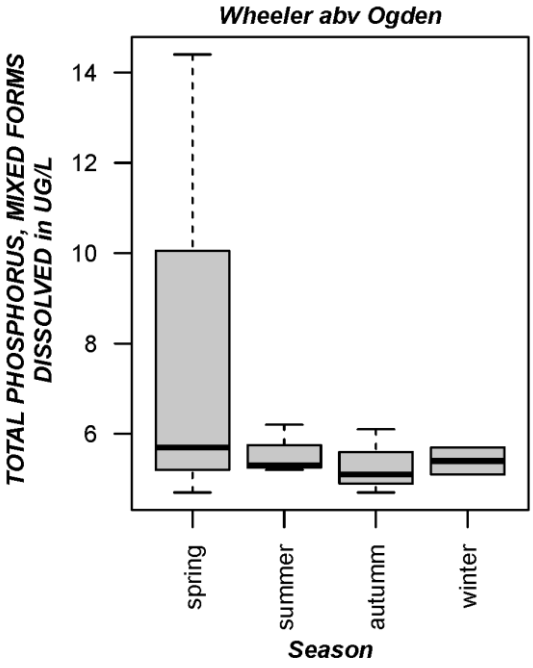

Wheeler abv Ogden
NITROGEN TOTAL in UG/L
600
500
400
300
200
2015
2016
2021
2022
Year

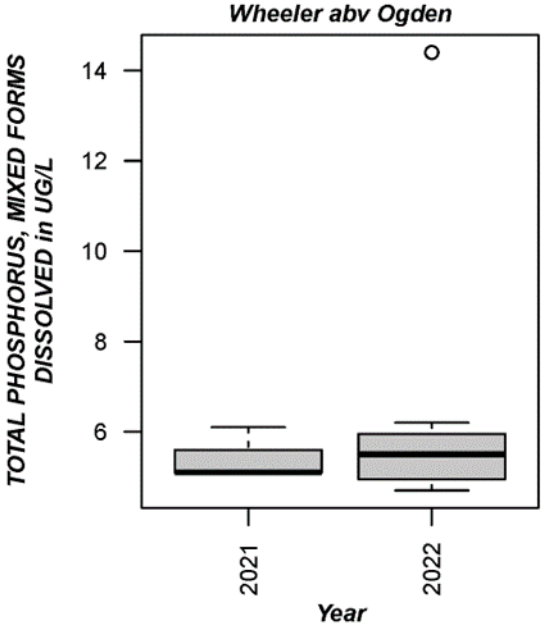

Wheeler abv Ogden
NITROGEN FILTERABLE in UG/L
1600
1400
1200
1000
800
600
400
200
spring
summer
autumn
winter
Season

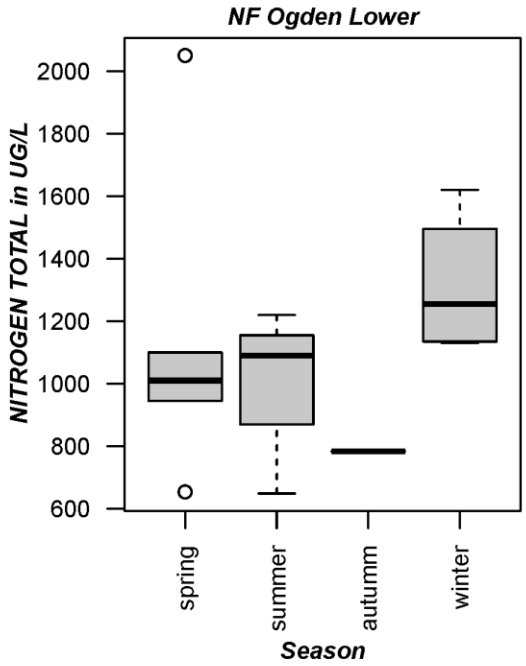

Wheeler abv Ogden
NITROGEN FILTERABLE in UG/L
1600
1400
1200
1000
800
600
400
200
2009
2021
2022
Year

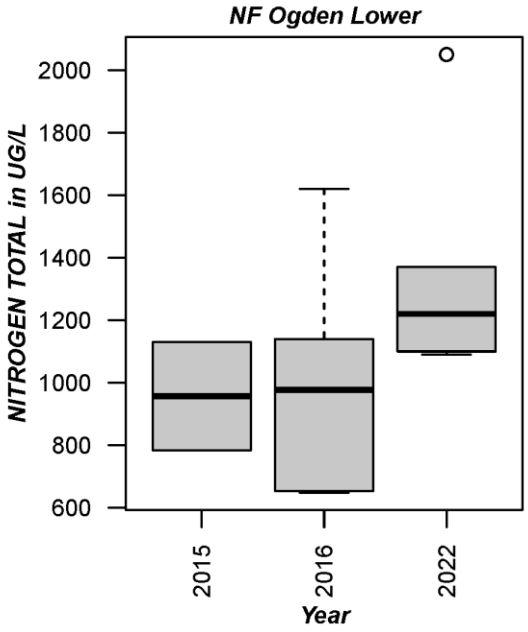

Wheeler abv Ogden
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
50
40
30
20
10
spring
summer
autumm
winter
Season

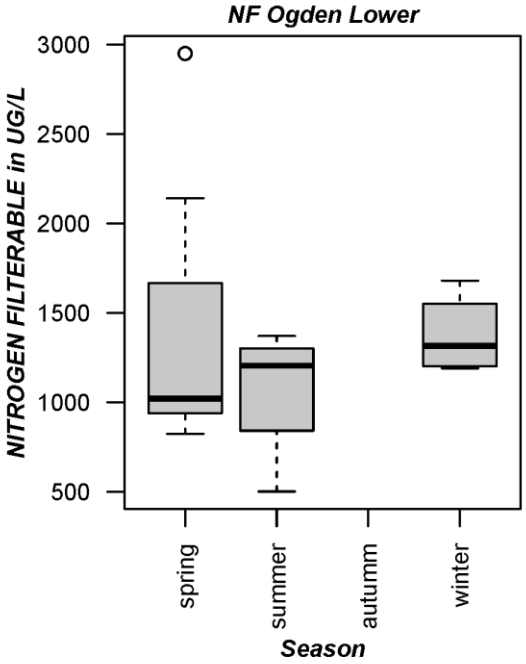

Wheeler abv Ogden
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
50
40
30
20
10
2021
2022
Year

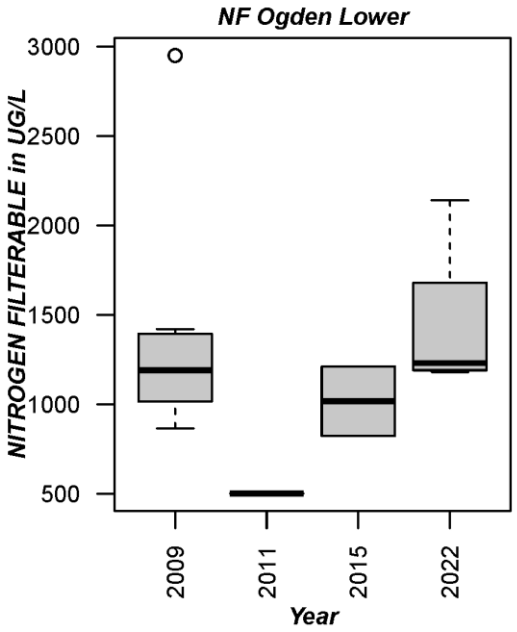

Wheeler abv Ogden
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
14
12
10
8
6
spring
summer
autumm
winter
Season

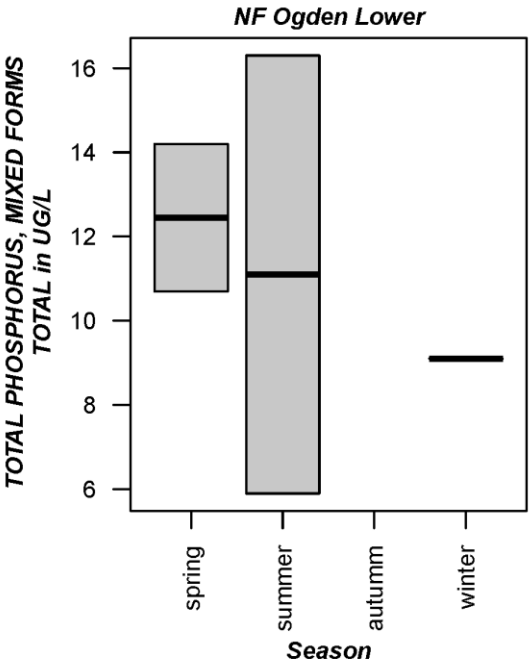

Wheeler abv Ogden
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
14
12
10
8
6
2021
2022
Year

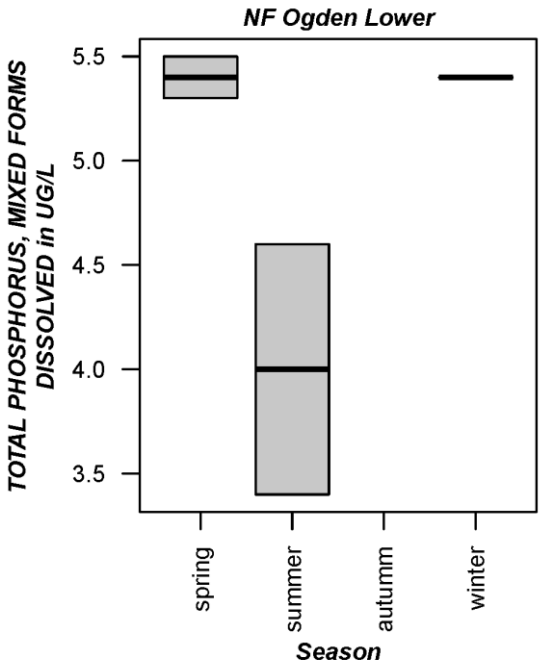

NF Ogden Lower
NITROGEN TOTAL in UG/L
2000
1800
1600
1400
1200
1000
800
600
spring
summer
autumm
winter
Season

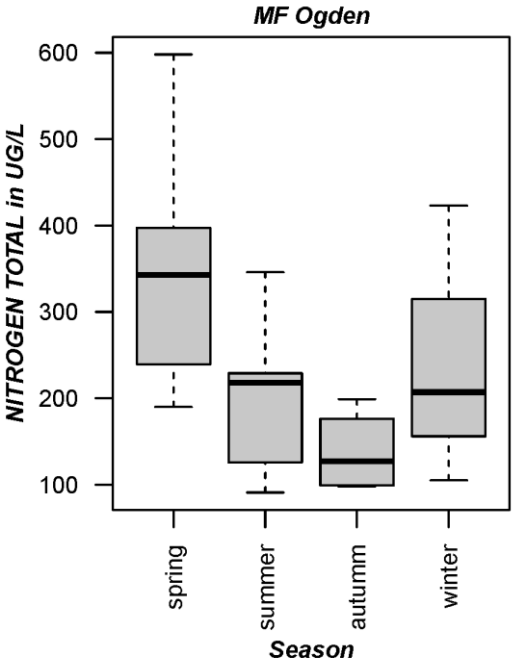

NF Ogden Lower
NITROGEN TOTAL in UG/L
2000
1800
1600
1400
1200
1000
800
600
2015
2016
2022
Year

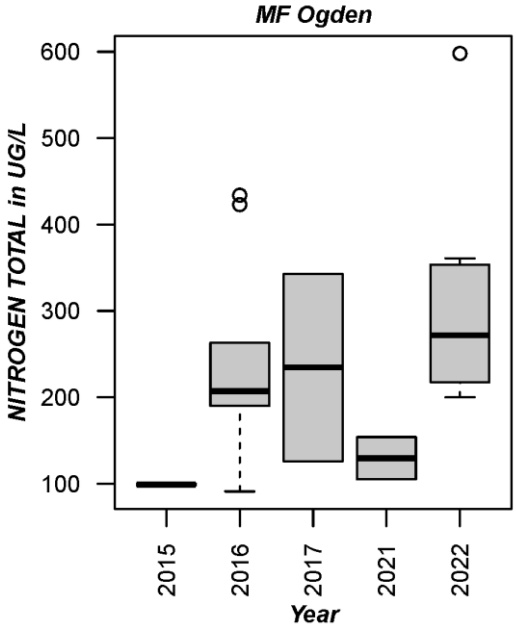

NF Ogden Lower
NITROGEN FILTERABLE in UG/L
3000
2500
2000
1500
1000
500
spring
summer
autumm
winter
Season

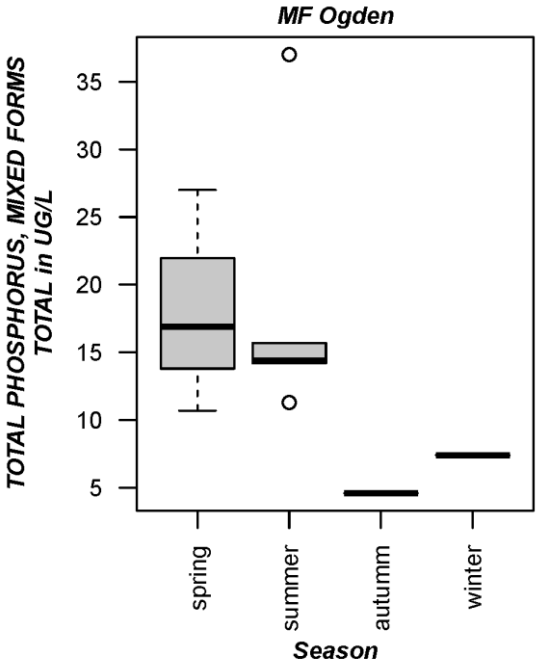

NF Ogden Lower
NITROGEN FILTERABLE in UG/L
3000
2500
2000
1500
1000
500
2009
2011
2015
2022
Year

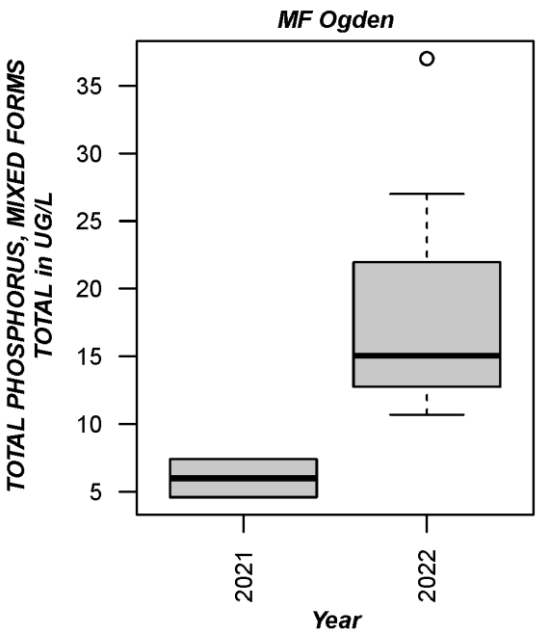

NF Ogden Lower
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
16
14
12
10
8
6
spring
summer
autumm
winter
Season

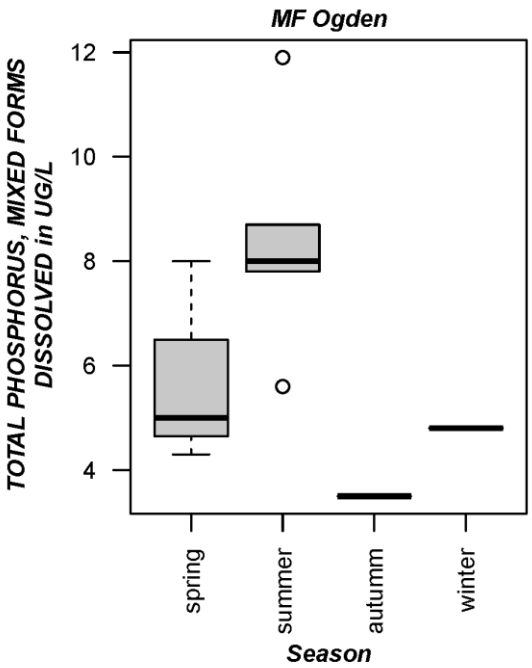

NF Ogden Lower
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
5.5
5.0
4.5
4.0
3.5
spring
summer
autumm
winter
Season

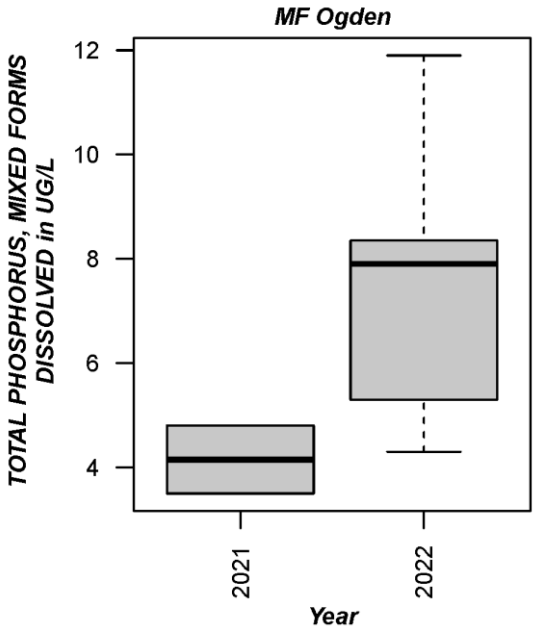

MF Ogden
NITROGEN TOTAL in UG/L
600
500
400
300
200
100
spring
summer
autumm
winter
Season

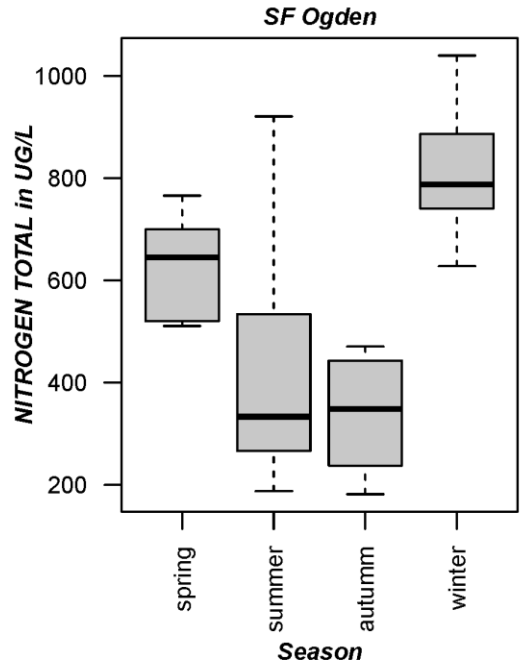

MF Ogden
NITROGEN TOTAL in UG/L
600
500
400
300
200
100
2015
2016
2017
2021
2022
Year

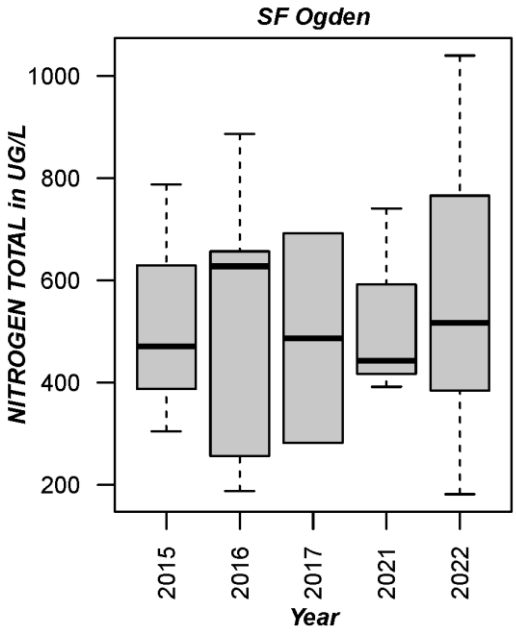

MF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
35
30
25
20
15
10
5
spring
summer
autumm
winter
Season

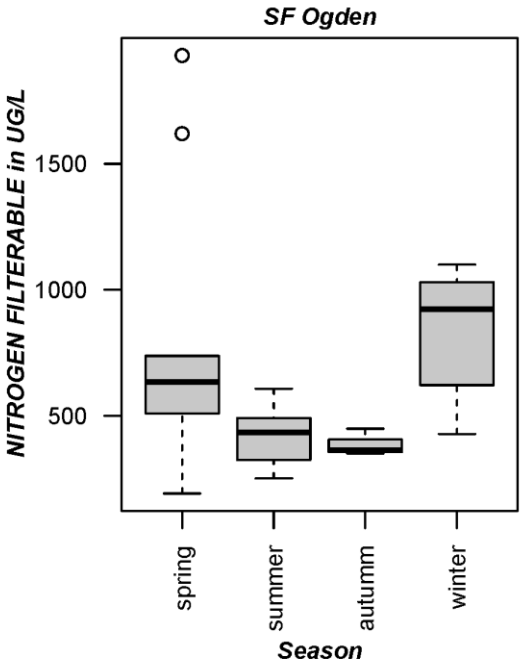

MF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
35
30
25
20
15
10
5
2021
2022
Year

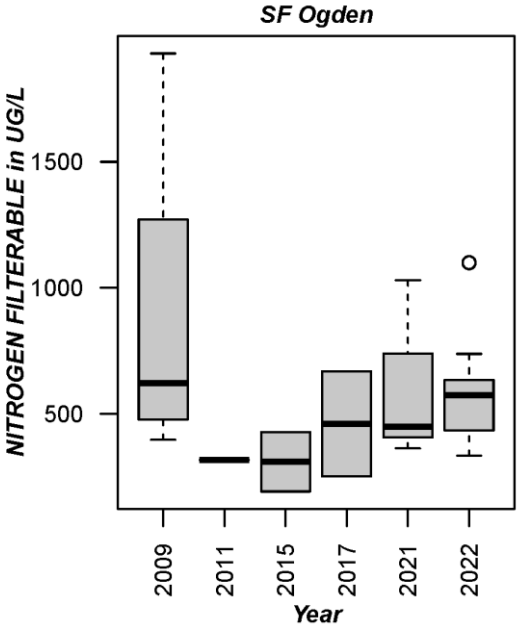

MF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
12
10
8
6
4
spring
summer
autumm
winter
Season

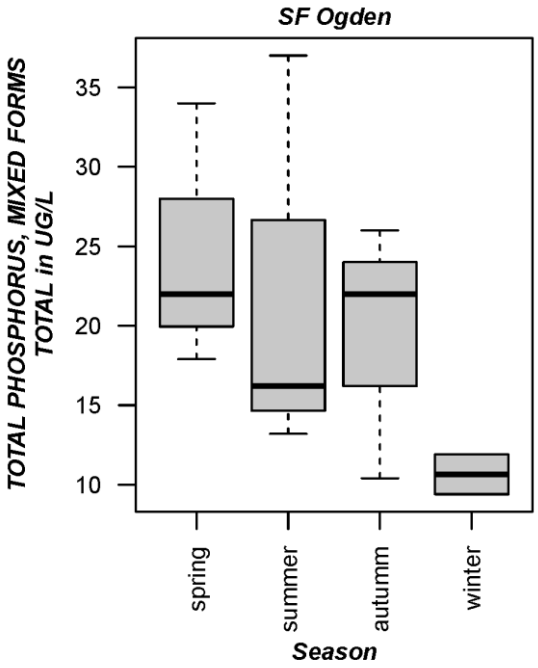

MF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
12
10
8
6
4
2021
2022
Year

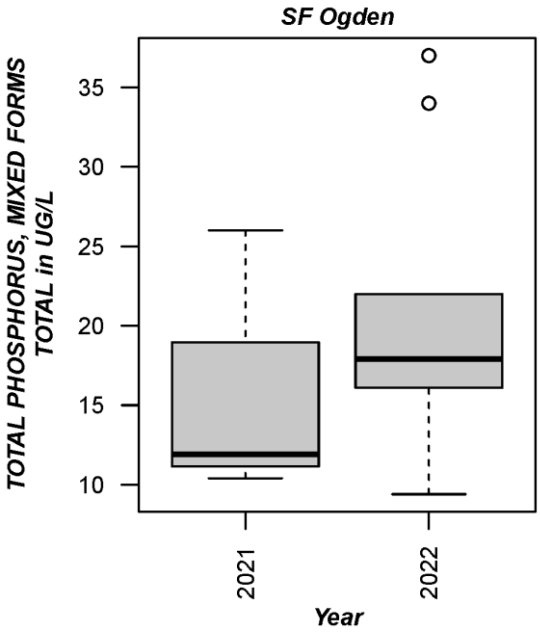

SF Ogden
NITROGEN TOTAL in UG/L
1000
800
600
400
200
spring
summer
autumn
winter
Season

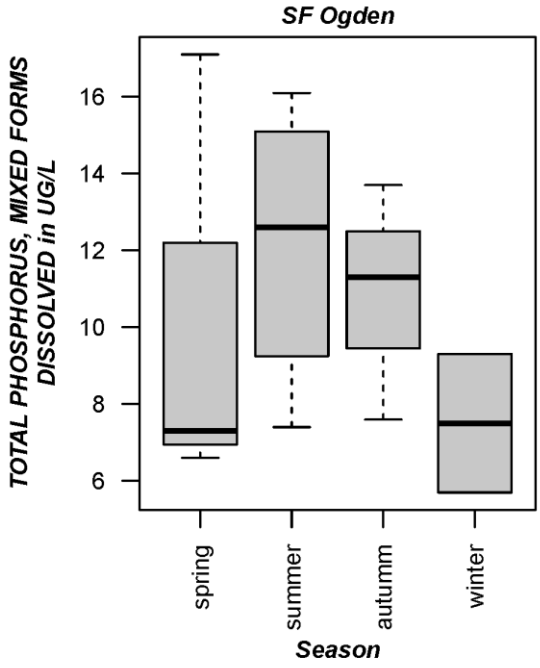

SF Ogden
NITROGEN TOTAL in UG/L
1000
800
600
400
200
2015
2016
2017
2021
2022
Year

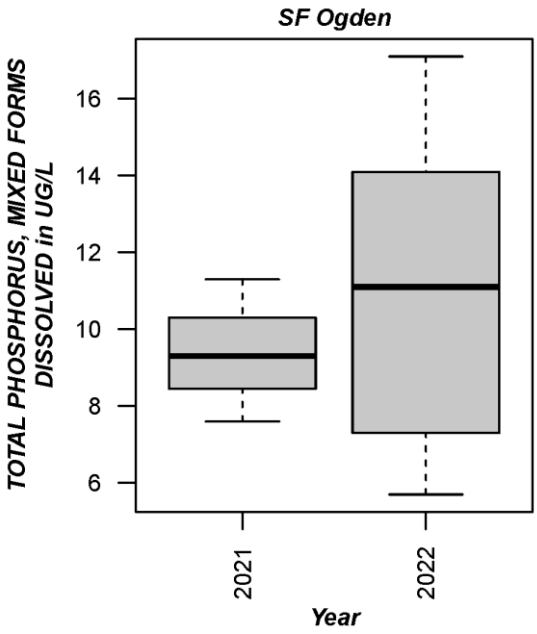

SF Ogden
NITROGEN FILTERABLE in UG/L
1500
1000
500
spring
summer
autumn
winter
Season


SF Ogden
NITROGEN FILTERABLE in UG/L
1500
1000
500
2009
2011
2015
2017
2021
2022
Year


SF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
35
30
25
20
15
10
spring
summer
autumn
winter
Season


SF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
TOTAL in UG/L
35
30
25
20
15
10
2021
2022
Year

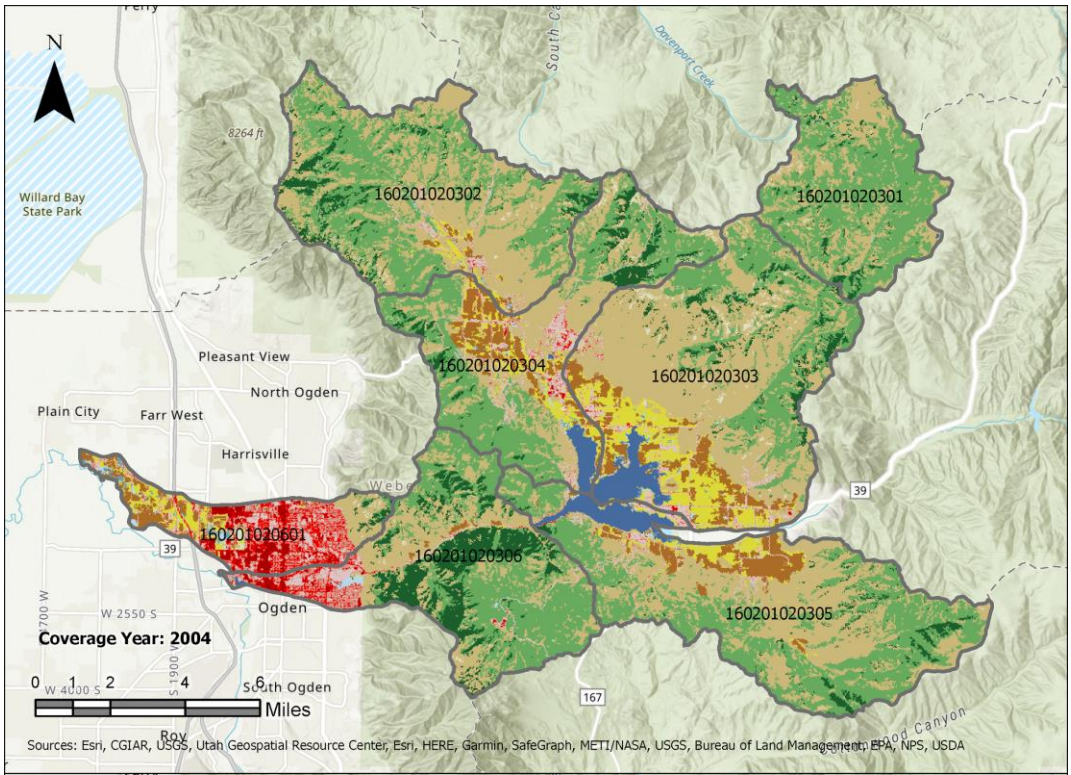

SF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
16
14
12
10
8
6
spring
summer
autumn
winter
Season

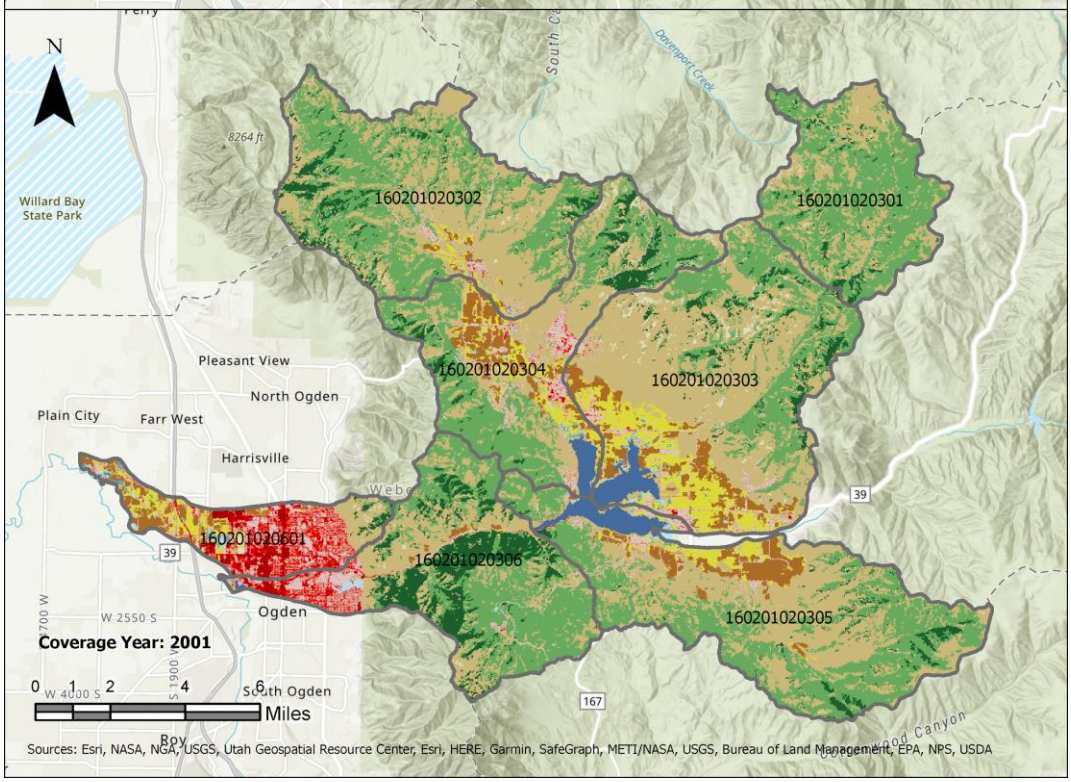

SF Ogden
TOTAL PHOSPHORUS, MIXED FORMS
DISSOLVED in UG/L
16
14
12
10
8
6
2021
2022
Year

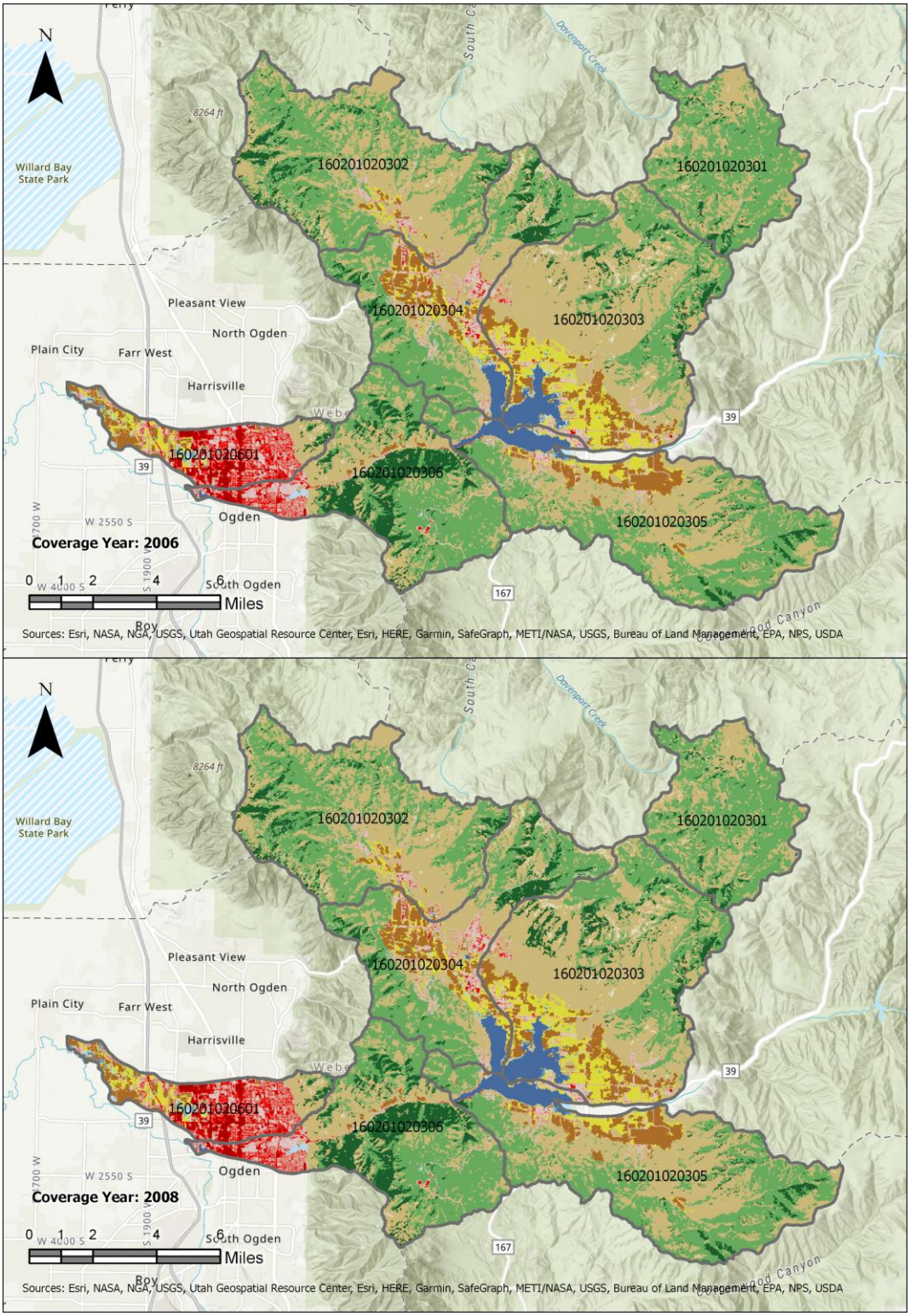
[Page Intentionally Left Blank]

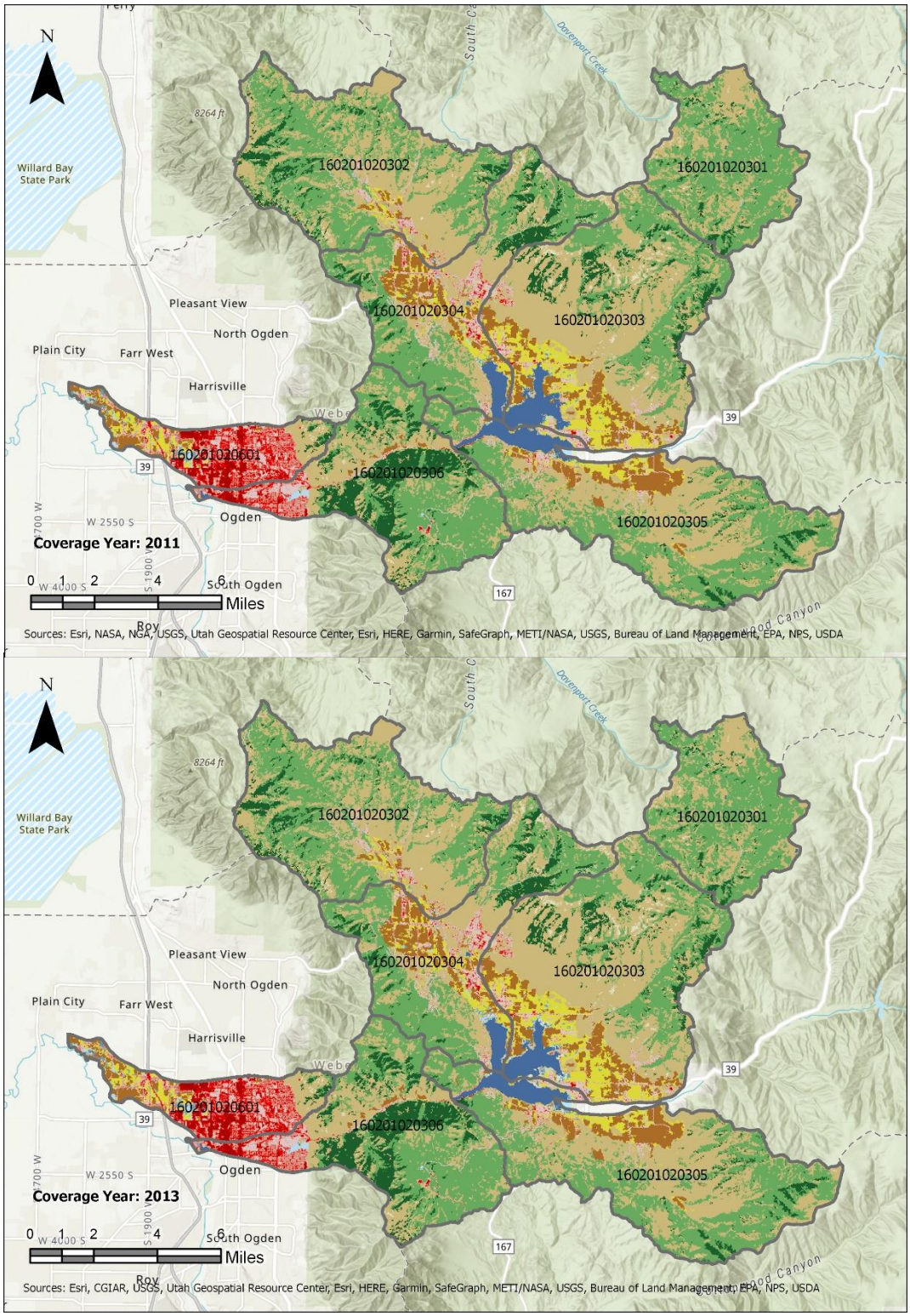
APPENDIX IV

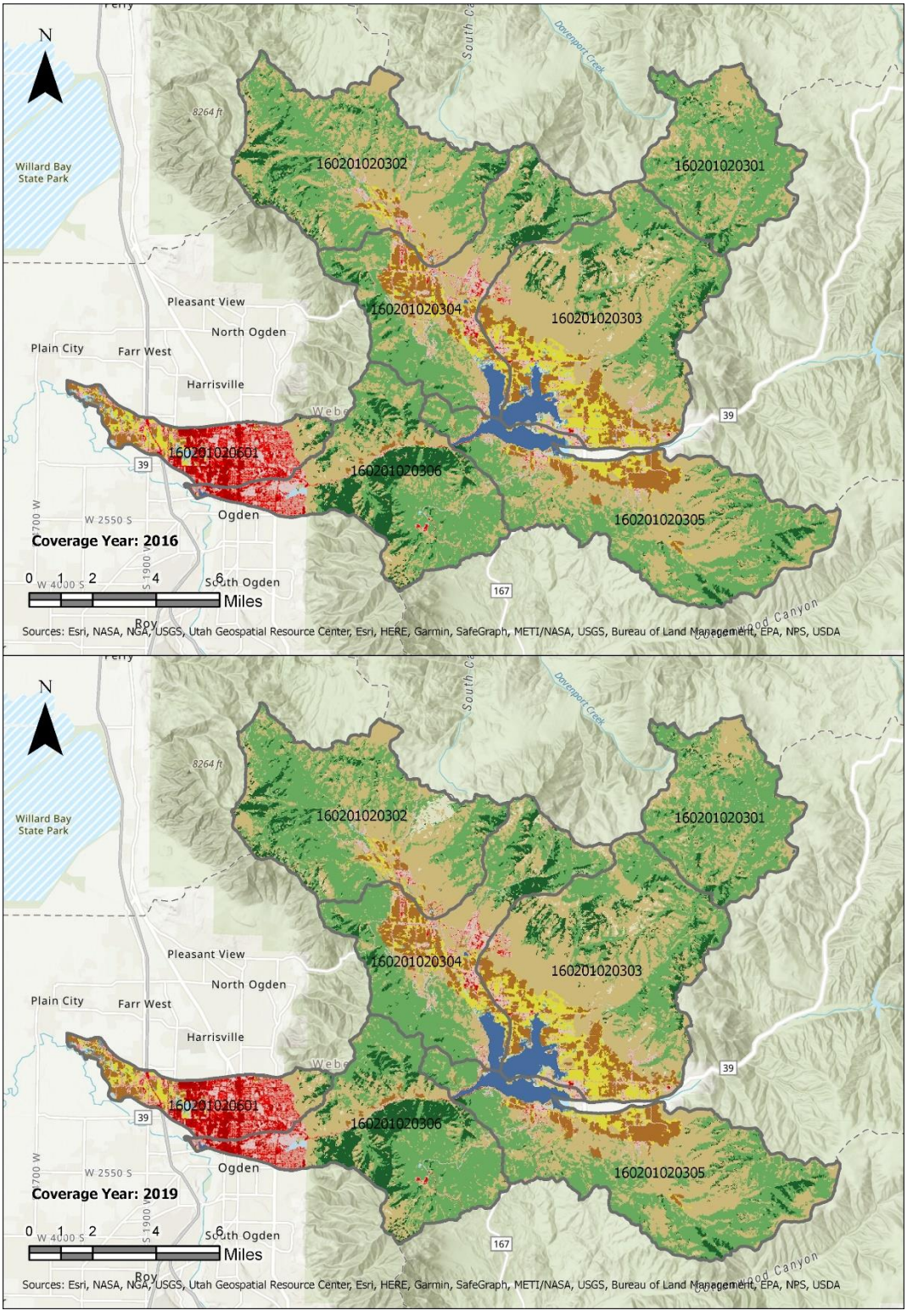
NATIONAL LAND COVER 2001-2019






N
Willard Bay State Park
8264 ft
Davenport Creek
160201020302
160201020301
160201020304
160201020303
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
Weber
160201020601
160201020306
160201020305
39
167
Ogden
W 2550 S
700 W
S 1900 W
W 4000 S
South Ogden
Roy
Coverage Year: 2006
0 1 2 4 6
Miles
Sources: Esri, NASA, NGA, USGS, Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA
N
Willard Bay State Park
8264 ft
Davenport Creek
160201020302
160201020301
160201020304
160201020303
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
Weber
160201020601
160201020306
160201020305
39
167
Ogden
W 2550 S
700 W
S 1900 W
W 4000 S
South Ogden
Roy
Coverage Year: 2008
0 1 2 4 6
Miles
Sources: Esri, NASA, NGA, USGS, Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA


N
Willard Bay State Park
8264 ft
160201020302
160201020301
160201020304
160201020303
160201020601
160201020306
160201020305
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
Ogden
South Ogden
Roy
39
167
W 2550 S
W 4000 S
Coverage Year: 2011
0 1 2 4 6
Miles
Sources: Esri, NASA, NGA, USGS, Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA
N
Willard Bay State Park
8264 ft
160201020302
160201020301
160201020304
160201020303
160201020601
160201020306
160201020305
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
Ogden
South Ogden
Roy
39
167
W 2550 S
W 4000 S
Coverage Year: 2013
0 1 2 4 6
Miles
Sources: Esri, CGIAR, USGS, Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA


N
Willard Bay State Park
8264 ft
160201020302
160201020301
160201020304
160201020303
160201020306
160201020305
160201020601
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
Ogden
South Ogden
Roy
39
167
W 2550 S
W 4000 S
S 1900 E
700 W
Coverage Year: 2016
0 1 2 4 6
Miles
Sources: Esri, NASA, NGA, USGS, Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA
N
Willard Bay State Park
8264 ft
160201020302
160201020301
160201020304
160201020303
160201020306
160201020305
160201020601
Pleasant View
North Ogden
Plain City
Farr West
Harrisville
Ogden
South Ogden
Roy
39
167
W 2550 S
W 4000 S
S 1900 E
700 W
Coverage Year: 2019
0 1 2 4 6
Miles
Sources: Esri, NASA, NGA, USGS, Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA

2001 TO 2011 CHANGES IN LAND USE CATEGORIES. CHANGE DETERMINED BY THE 10'S PLACE IN THE NLCD CLASS

From Category	To Category	1602010203 02	1602010 20305	1602010 20303	1602010 20306	1602010 20304	1602010 20301	1602010 20601	Total (acres)
Forest	Water	0.00	0.00	0.00	0.22	0.22	0.00	0.00	0.44
Shrubland	Water	0.00	52.02	103.82	0.00	18.01	2.22	0.00	176.07
Herbaceous	Water	0.00	0.44	2.00	0.00	0.00	0.00	0.00	2.45
Planted/Cultivated	Water	0.00	20.23	75.59	0.00	30.23	0.00	0.67	126.72
Wetlands	Water	0.00	42.68	79.36	0.00	32.90	0.00	0.00	154.95
Forest	Developed	0.67	1.56	0.00	0.44	2.45	0.44	0.00	5.56
Shrubland	Developed	29.79	23.56	67.14	21.79	78.25	0.00	42.46	262.99
Herbaceous	Developed	0.00	0.00	0.00	0.00	0.00	0.00	46.46	46.46
Planted/Cultivated	Developed	6.45	8.00	58.91	2.45	73.81	0.00	305.90	455.51
Wetlands	Developed	1.11	0.00	0.00	9.78	1.33	0.00	26.23	38.46
Water	Developed	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.44
Planted/Cultivated	Barren	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.44
Shrubland	Forest	6.00	2.67	634.47	3.11	180.29	3.11	0.00	829.66
Herbaceous	Forest	0.00	0.00	1.78	0.22	2.00	0.00	0.00	4.00
Planted/Cultivated	Forest	1.11	0.00	0.00	0.00	0.00	0.00	0.00	1.11
Water	Forest	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.67
Water	Shrubland	0.00	0.22	0.00	0.00	0.44	0.00	0.00	0.67
Forest	Shrubland	53.35	5.56	13.12	11.78	2.00	14.23	0.00	100.04
Herbaceous	Shrubland	0.00	0.00	112.93	0.00	13.56	0.22	0.00	126.72
Planted/Cultivated	Shrubland	11.78	33.57	34.24	3.33	66.47	0.00	0.00	149.39
Wetlands	Shrubland	0.00	0.44	4.00	0.00	0.44	0.00	0.00	4.89
Water	Herbaceous	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.22
Forest	Herbaceous	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.44
Shrubland	Herbaceous	0.00	6.00	1.33	0.00	0.67	0.00	0.22	8.23
Planted/Cultivated	Herbaceous	0.00	0.00	3.11	0.44	0.00	0.00	0.00	3.56
Forest	Planted/Cultivated	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.22
Shrubland	Planted/Cultivated	88.48	61.14	70.03	17.34	145.61	0.00	4.00	386.60
Herbaceous	Planted/Cultivated	0.00	4.67	2.22	0.00	0.00	0.00	0.00	6.89
Wetlands	Planted/Cultivated	0.89	0.00	0.00	0.00	1.33	0.00	0.89	3.11
Shrubland	Wetlands	0.00	0.22	0.00	0.00	0.22	0.00	0.00	0.44
Planted/Cultivated	Wetlands	0.67	0.22	0.67	0.00	0.89	0.00	2.22	4.67

2011 TO 2019 CHANGES IN LAND USE CATEGORIES

From Category	To Category	160201 020302	160201 020305	1602010 20303	1602010 20306	1602010 20304	1602010 20301	1602010 20601	Total (acres)
Forest	Water	0.0	0.0	0.0	0.7	0.2	0.4	0.0	1.3
Shrubland	Water	1.8	8.4	11.3	0.0	17.1	0.0	0.0	38.7
Planted/Cultivated	Water	0.0	0.0	1.1	0.0	0.0	0.0	0.2	1.3
Wetlands	Water	0.0	4.4	2.7	0.0	0.7	0.0	0.0	7.8
Water	Developed	0.0	0.0	2.4	0.0	0.0	0.0	0.0	2.4
Forest	Developed	0.0	0.0	0.0	0.2	10.7	1.8	0.0	12.7
Shrubland	Developed	10.7	16.2	1.8	2.4	53.6	0.4	8.7	93.8
Herbaceous	Developed	0.0	0.0	0.0	0.0	0.7	0.0	3.3	4.0
Planted/Cultivated	Developed	0.4	18.7	34.0	0.0	6.0	0.0	89.6	148.7
Wetlands	Developed	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Water	Barren	0.0	2.9	2.9	0.0	0.2	0.0	0.0	6.0
Herbaceous	Barren	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2
Planted/Cultivated	Barren	0.0	0.9	2.9	0.0	0.0	0.0	0.0	3.8
Water	Forest	0.0	2.0	0.0	0.2	0.0	0.0	0.0	2.2
Shrubland	Forest	1149.8	319.5	666.3	662.7	818.1	42.7	0.0	3659.0
Herbaceous	Forest	1.8	0.0	0.0	0.0	8.0	0.0	0.0	9.8
Planted/Cultivated	Forest	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3
Forest	Shrubland	21.6	56.9	23.1	41.1	47.6	103.4	0.7	294.3
Herbaceous	Shrubland	0.0	6.0	40.2	0.0	0.0	0.0	0.0	46.2
Planted/Cultivated	Shrubland	11.3	25.6	3.3	3.3	13.6	0.0	0.0	57.1
Water	Herbaceous	0.0	18.0	32.7	0.0	2.2	0.0	0.0	52.9
Forest	Herbaceous	200.7	2.4	0.2	0.0	0.0	0.4	0.0	203.9
Shrubland	Herbaceous	268.5	0.2	0.7	0.0	0.0	0.0	0.0	269.4
Planted/Cultivated	Herbaceous	0.0	2.2	2.0	0.0	0.0	0.0	0.0	4.2
Wetlands	Herbaceous	0.0	0.0	0.7	0.0	0.2	0.0	0.0	0.9
Water	Planted/Cultivated	0.0	1.3	0.2	0.0	0.4	0.0	0.0	2.0
Forest	Planted/Cultivated	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Shrubland	Planted/Cultivated	33.6	1.6	28.2	6.2	8.0	0.0	0.0	77.6

From Category	To Category	160201020302	160201020305	160201020303	160201020306	160201020304	160201020301	160201020601	Total (acres)
Wetlands	Planted/Cultivated	0.4	0.4	4.0	0.0	1.1	0.0	0.0	6.0
Water	Wetlands	0.0	8.7	12.2	0.0	8.9	0.0	0.0	29.8
Barren	Wetlands	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2
Shrubland	Wetlands	0.0	0.2	2.4	0.0	0.4	0.0	0.0	3.1
Planted/Cultivated	Wetlands	1.1	2.2	0.0	0.0	1.3	0.0	0.0	4.7

NLCD Sources

Dewitz, J., and U.S. Geological Survey, 2021, National Land Cover Database (NLCD) 2019 Products (ver. 2.0, June 2021): U.S. Geological Survey data release, https://doi.org/10.5066/P9KZCM54

Homer, Collin G., Dewitz, Jon A., Jin, Suming, Xian, George, Costello, C., Danielson, Patrick, Gass, L., Funk, M., Wickham, J., Stehman, S., Auch, Roger F., Riitters, K. H., Conterminous United States land cover change patterns 2001–2016 from the 2016 National Land Cover Database: ISPRS Journal of Photogrammetry and Remote Sensing, v. 162, p. 184–199, at https://doi.org/10.1016/j.isprsjprs.2020.02.019

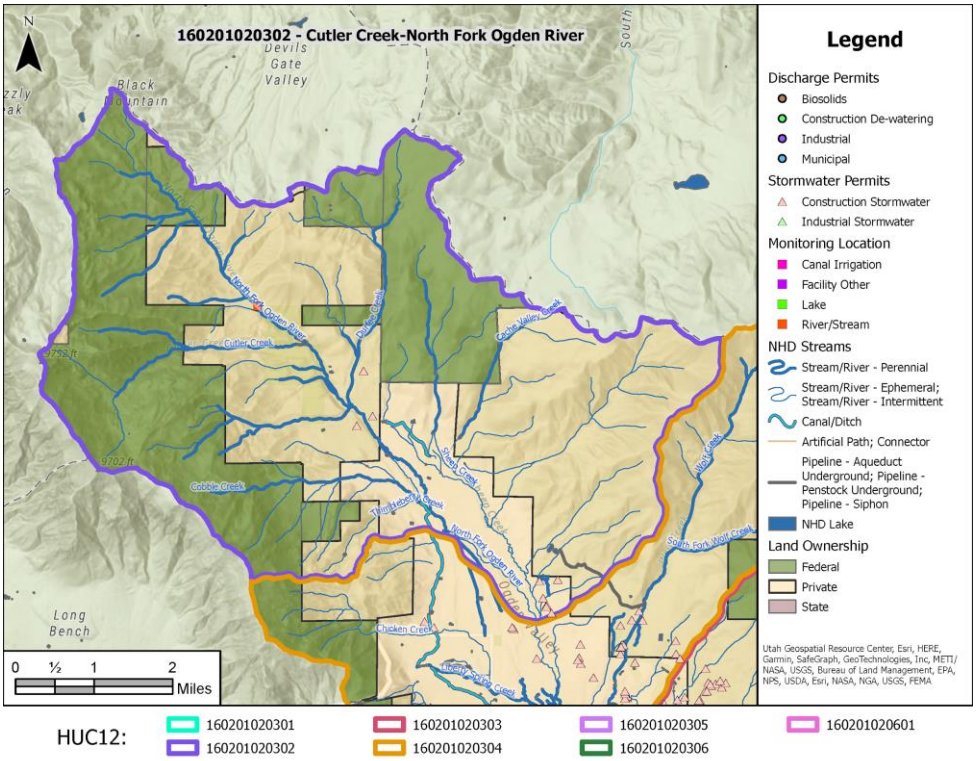
Jin, Suming, Homer, Collin, Yang, Limin, Danielson, Patrick, Dewitz, Jon, Li, Congcong, Zhu, Z., Xian, George, Howard, Danny, Overall methodology design for the United States National Land Cover Database 2016 products: Remote Sensing, v. 11, no. 24, at https://doi.org/10.3390/rs11242971

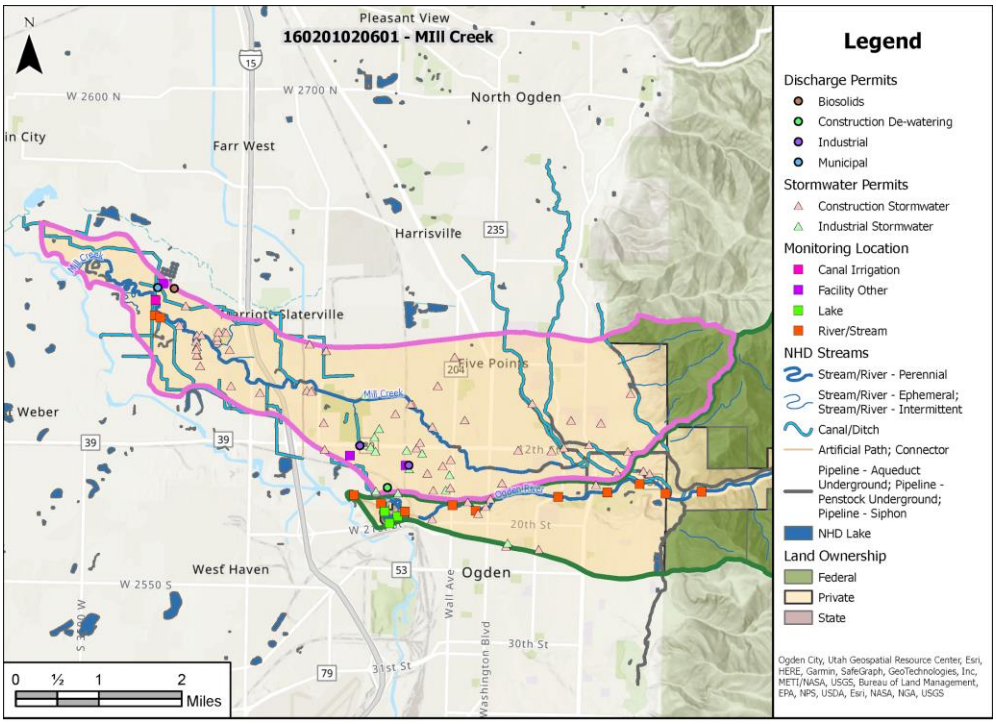
Wickham, J., Stehman, S.V., Sorenson, D.G., Gass, L., and Dewitz, J.A., 2021, Thematic accuracy assessment of the NLCD 2016 land cover for the conterminous United States: Remote Sensing of Environment, v. 257, art. no. 112357, at https://doi.org/10.1016/j.rse.2021.112357

Yang, L., Jin, S., Danielson, P., Homer, C., Gass, L., Case, A., Costello, C., Dewitz, J., Fry, J., Funk, M., Grannemann, B., Rigge, M. and G. Xian. 2018. A New Generation of the United States National Land Cover Database: Requirements, Research Priorities, Design, and Implementation Strategies, ISPRS Journal of Photogrammetry and Remote Sensing, 146, pp.108-123.

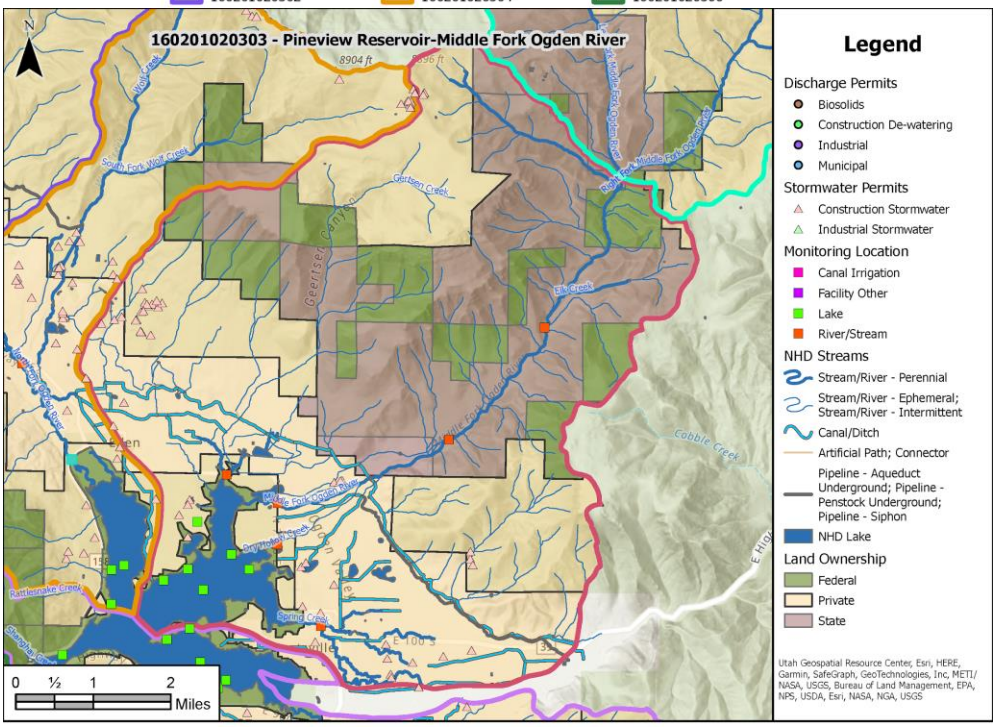
APPENDIX V

LOCATION OF STORMWATER PERMITS BY SUBWATERSHED

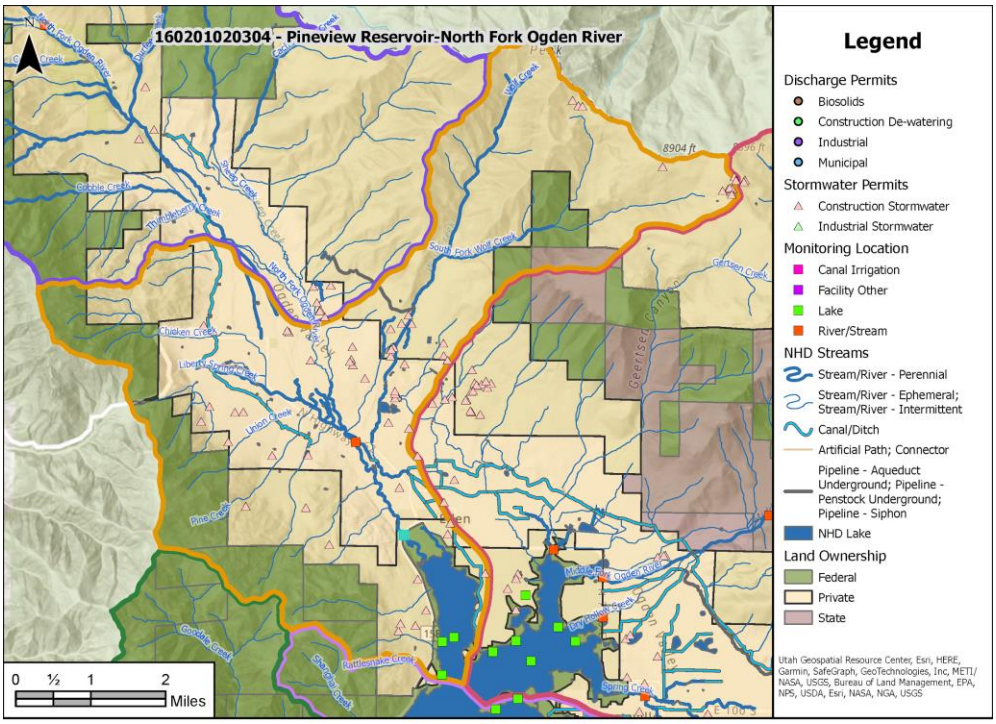


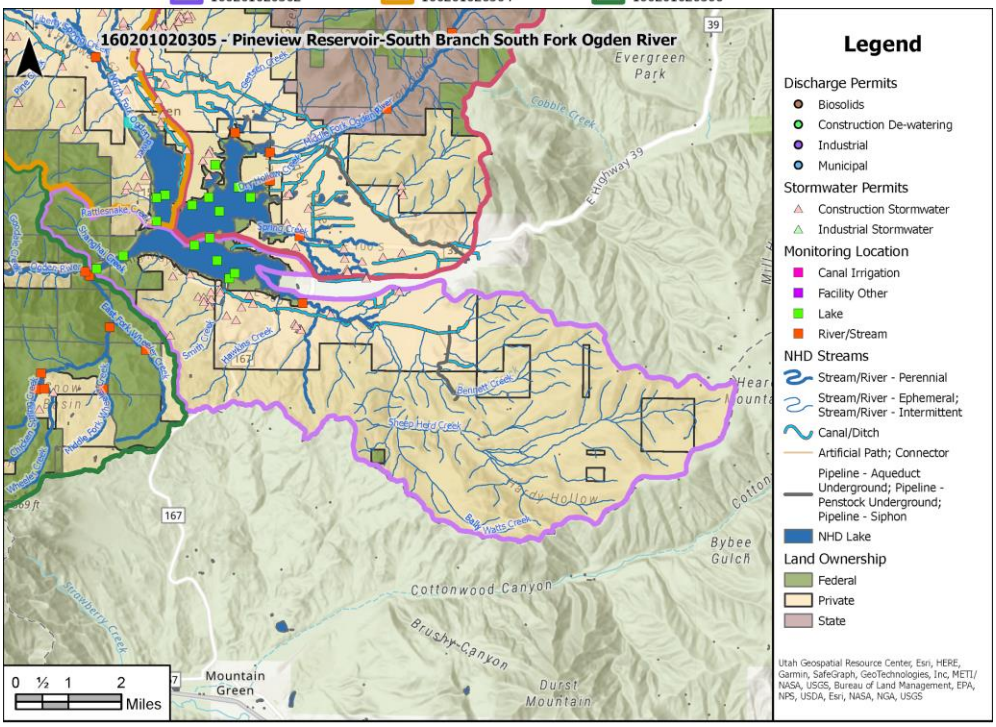


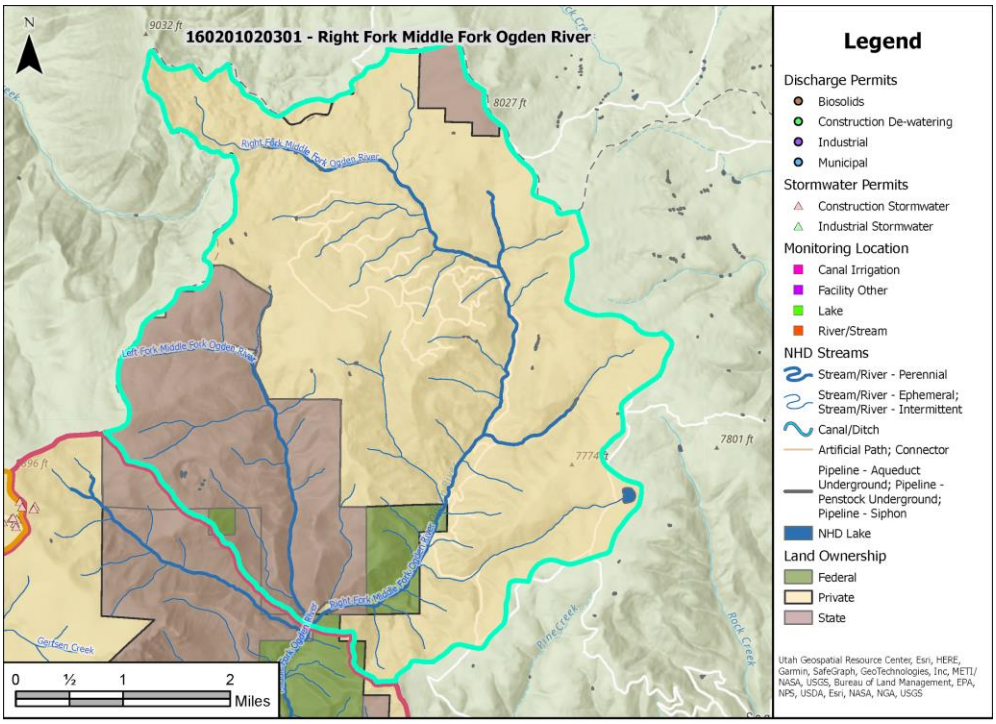
HUC12: 160201020301 160201020303 160201020305 160201020601
160201020302 160201020304 160201020306

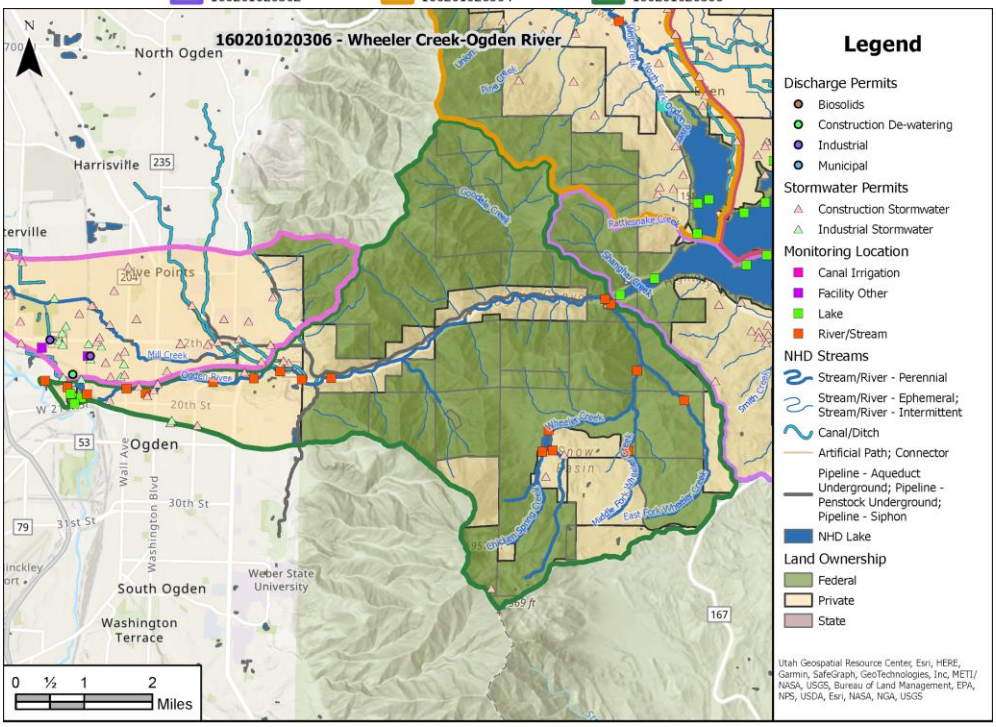


HUC12: 160201020301 160201020303 160201020305 160201020601
160201020302 160201020304 160201020306


160201020304 - Pineview Reservoir-North Fork Ogden River
Legend
Discharge Permits
Biosolids
Construction De-watering
Industrial
Municipal
Stormwater Permits
Construction Stormwater
Industrial Stormwater
Monitoring Location
Canal Irrigation
Facility Other
Lake
River/Stream
NHD Streams
Stream/River - Perennial
Stream/River - Ephemeral; Stream/River - Intermittent
Canal/Ditch
Artificial Path; Connector
Pipeline - Aqueduct Underground; Pipeline - Penstock Underground; Pipeline - Siphon
NHD Lake
Land Ownership
Federal
Private
State
Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/ NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, Esri, NASA, NGA, USGS
0 ½ 1 2 Miles
HUC12:
160201020301
160201020302
160201020303
160201020304
160201020305
160201020306
160201020601


160201020305 - Pineview Reservoir-South Branch South Fork Ogden River
Legend
Discharge Permits
Biosolids
Construction De-watering
Industrial
Municipal
Stormwater Permits
Construction Stormwater
Industrial Stormwater
Monitoring Location
Canal Irrigation
Facility Other
Lake
River/Stream
NHD Streams
Stream/River - Perennial
Stream/River - Ephemeral; Stream/River - Intermittent
Canal/Ditch
Artificial Path; Connector
Pipeline - Aqueduct Underground; Pipeline - Penstock Underground; Pipeline - Siphon
NHD Lake
Land Ownership
Federal
Private
State
Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/ NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, Esri, NASA, NGA, USGS
Evergreen Park
Cobbler Creek
E Highway 39
Sheep Herd Creek
Bybee Gulch
Cottonwood Canyon
Brushy Canyon
Durst Mountain
Mountain Green
0 ½ 1 2 Miles
HUC12:
160201020301
160201020302
160201020303
160201020304
160201020305
160201020306
160201020601


160201020301 - Right Fork Middle Fork Ogden River
Legend
Discharge Permits
Biosolids
Construction De-watering
Industrial
Municipal
Stormwater Permits
Construction Stormwater
Industrial Stormwater
Monitoring Location
Canal Irrigation
Facility Other
Lake
River/Stream
NHD Streams
Stream/River - Perennial
Stream/River - Ephemeral; Stream/River - Intermittent
Canal/Ditch
Artificial Path; Connector
Pipeline - Aqueduct Underground; Pipeline - Penstock Underground; Pipeline - Siphon
NHD Lake
Land Ownership
Federal
Private
State
Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/ NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, Esri, NASA, NGA, USGS
0 ½ 1 2 Miles
HUC12:
160201020301
160201020302
160201020303
160201020304
160201020305
160201020306
160201020601


160201020306 - Wheeler Creek-Ogden River
Legend
Discharge Permits
Biosolids
Construction De-watering
Industrial
Municipal
Stormwater Permits
Construction Stormwater
Industrial Stormwater
Monitoring Location
Canal Irrigation
Facility Other
Lake
River/Stream
NHD Streams
Stream/River - Perennial
Stream/River - Ephemeral; Stream/River - Intermittent
Canal/Ditch
Artificial Path; Connector
Pipeline - Aqueduct Underground; Pipeline - Penstock Underground; Pipeline - Siphon
NHD Lake
Land Ownership
Federal
Private
State
Utah Geospatial Resource Center, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/ NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, Esri, NASA, NGA, USGS
North Ogden
Harrisville
Five Points
Ogden
South Ogden
Washington Terrace
Weber State University
0 ½ 1 2 Miles
HUC12:
160201020301
160201020302
160201020303
160201020304
160201020305
160201020306
160201020601

APPENDIX VI

PLET NITROGEN, PHOSPHORUS, AND SEDIMENT LOAD ESTIMATES BY SOURCE

PLET NITROGEN LOAD BY SOURCE

HUC	N Load by Source (lb N/yr)								
	Urban	Cropland	Pasture-land	Forest	Feedlot	Septic	Gully	Stream bank	Total
160201020301 - Right Fork Middle Fork Ogden River	99	0	16	1,151	0	33	0	0	1,299
160201020302 - Cutler Creek-North Fork Ogden River	1,773	1,102	970	2,565	739	1,221	0	0	8,371
160201020303 - Pineview Reservoir-Middle Fork Ogden River	4,194	8,056	7,787	2,582	4,043	3,014	0	0	29,675
160201020304 - Pineview Reservoir-North Fork Ogden River	5,527	5,977	2,946	1,741	2,478	4,170	0	0	22,840
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	2,518	5,563	2,287	2,603	2,043	2,828	0	0	17,841
160201020306 - Wheeler Creek-Ogden River	6,264	503	46	2,040	109	785	0	0	9,747
160201020601 - Mill Creek	15,021	3,113	2,065	131	1,087	0	0	0	21,417
Grand Total	**35,396**	**24,315**	**16,116**	**12,813**	**10,498**	**12,051**	**0**	**0**	**111,189**

PLET PHOSPHORUS LOAD BY SOURCE

HUC	P Load (lb P/yr)								
	Urban	Cropland	Pasture-land	Forest	Feedlot	Septic	Gully	Stream-bank	Total
160201020301 - Right Fork Middle Fork Ogden River	15	0	2	526	0	13	0	0	556
160201020302 - Cutler Creek-North Fork Ogden River	273	308	113	1,213	148	478	0	0	2,533
160201020303 - Pineview Reservoir-Middle Fork Ogden River	647	2,222	888	1,224	809	1,180	0	0	6,970
160201020304 - Pineview Reservoir-North Fork Ogden River	852	1,685	347	822	496	1,633	0	0	5,835
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	388	1,545	263	1,233	409	1,108	0	0	4,945
160201020306 - Wheeler Creek-Ogden River	966	142	5	963	22	307	0	0	2,405
160201020601 - Mill Creek	2,316	916	261	61	217	0	0	0	3,772
Grand Total	**5,458**	**6,816**	**1,880**	**6,043**	**2,100**	**4,720**	**0**	**0**	**27,017**

PLET SEDIMENT LOAD BY SOURCE

HUC	Sediment Load (Ton/year)								
	Urban	Cropland	Pasture-land	Forest	Feedlot	Septic	Gully	Stream bank	Total
160201020301 - Right Fork Middle Fork Ogden River	2	0	1	135	0	0	0	0	138
160201020302 - Cutler Creek-North Fork Ogden River	41	184	40	188	0	0	0	0	453
160201020303 - Pineview Reservoir-Middle Fork Ogden River	96	1,307	306	180	0	0	0	0	1,890
160201020304 - Pineview Reservoir-North Fork Ogden River	127	1,019	127	132	0	0	0	0	1,406
160201020305 - Pineview Reservoir-South Branch South Fork Ogden River	58	917	93	187	0	0	0	0	1,254
160201020306 - Wheeler Creek-Ogden River	144	86	2	154	0	0	0	0	386
160201020601 - Mill Creek	345	584	107	12	0	0	0	0	1,048
Total	**814**	**4,096**	**676**	**988**	**0**	**0**	**0**	**0**	**6,574**