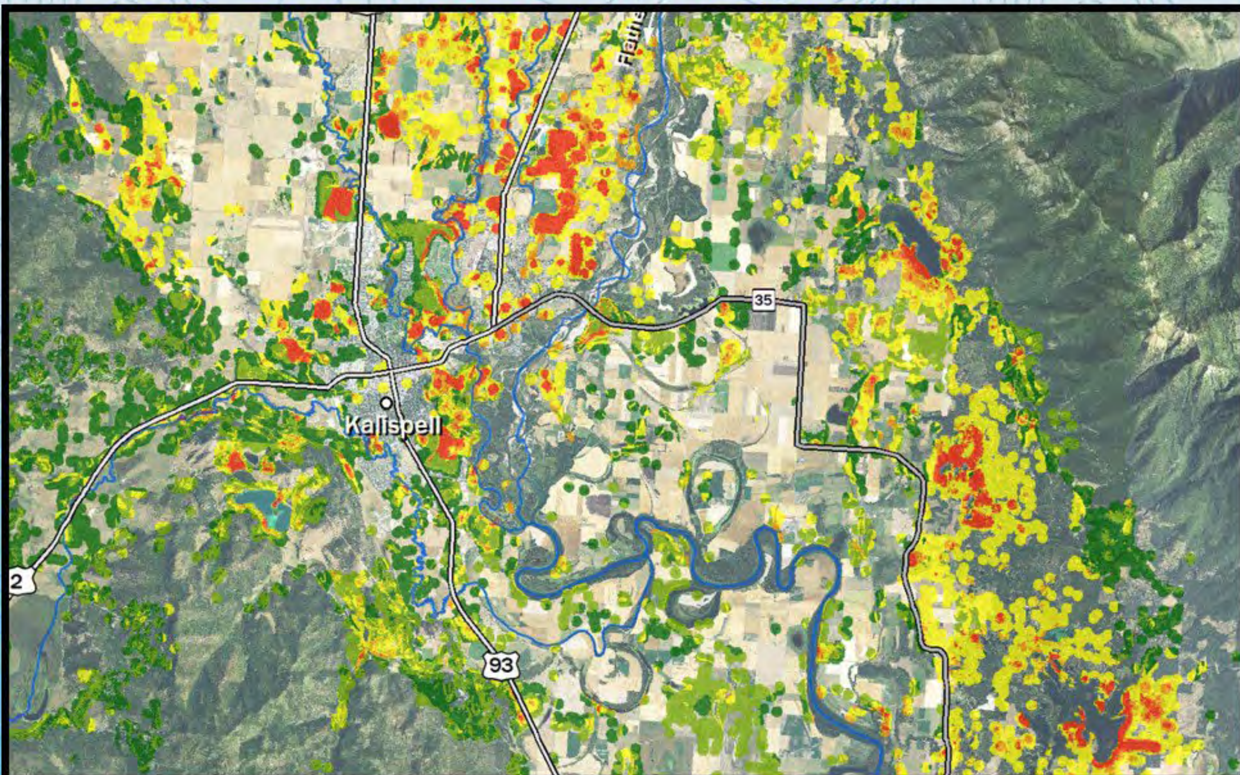
Onsite Wastewater Risk Analysis

GIS Technical Report



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Executive Summary

Non-point source (NPS) pollution is the leading cause of water quality issues in the United States and Montana. The Flathead Basin is home to large clear lakes, clean cold rivers, and extensive groundwater resources that support our economy, promote robust ecological benefits and environmental services, and provide vast recreational opportunities to our community. The Flathead Basin Commission (FBC) adopted a strategic plan in 2019 that focused on addressing non-point source pollution issues impacting water quality in the Flathead Basin. While non-point source pollution includes many different divergent sources, septic leachate is one that has been well-documented in the Flathead Basin dating back to the 1970s.

Septic systems offer a unique risk to surface and ground waters given the difficulty to identify poorly functioning and failed systems. Septic systems that are properly planned, designed, sited, installed, operated, and maintained can achieve satisfactory wastewater treatment. However, systems that are sited in densities that exceed the treatment capacity of regional soils and systems that are outdated or poorly designed, installed, operated, or maintained can pollute water resources. The main septic leachate pollutants include nitrogen, phosphorous, pharmaceuticals and personal care products (PPCPs), viruses, and bacteria, all of which have a negative impact on human health and the ecosystem. Excess nutrients threaten the Flathead Basin's clear lakes and rivers by promoting algae growth and blooms in water bodies. These impacts have been documented in previous reports on Flathead Lake and Whitefish Lake where septic systems were identified as a significant contributor of water quality degradation (Jourdonnais and Stanford 1985 and WLI 2012).

FBC formed the On-site Wastewater Treatment Committee to help identify the scope and extent of the septic leachate problem and provide potential solutions to address the issue. The committee identified the need to better understand the spatial dynamics of septic systems and potential pollution in the basin. River Design Group, Inc. (RDG) was contracted to use existing public spatial data to map the risk of septic systems. The two primary goals were to model the existing risk from current septic systems and develop a tool to predict the effectiveness of future septic systems across the basin. Together, these results provide the needed tools for policy makers, regulatory agencies, and the public to start addressing non-point source pollution from septic systems.

To create a model that predicts the effectiveness of a septic system's performance, the On-site Wastewater Treatment Committee identified a set of geophysical risk factors related to system performance and pollutant transport. These factors included slope, groundwater depth, soil treatment capacity, and distance to surface water. Criteria specific to each risk factor were developed to assign a range of risk from low to high. Each factor was mapped for associated septic system risk using publicly accessible spatial datasets. A physical risk model was developed to simulate the cumulative risk of all factors combined. The maps from this model depict the potential risk for septic performance across Flathead County and Lake County (Figure A-7 and Figure B-5). Very high-risk zones in Flathead County are consolidated in the valley floor surrounding the Flathead River and tributaries where higher levels of development exist. Lake County's very high-risk zones are more dispersed and in proximity to waterbodies including Flathead Lake, Swan Lake, Swan River, and Jocko River. The valley floor in Lake County, where most agricultural and rural development has occurred, has limited physical risks except for surrounding creeks and streams. This model can be used as a tool by policy makers, planners, regulatory agencies, and the public to identify areas where septic systems are performing, or likely to perform, poorly.

To characterize the risk from existing septic systems a series of analyses were conducted in Flathead County, where septic system permits have been converted into a spatial dataset. Analysis of the septic permit database revealed an aging population of systems throughout Flathead County (Figure A-1). An age weighted density analysis of septic systems was conducted to find concentrations of old septic systems (Figure A-2). The oldest and densest clusters of septic systems are surrounding existing municipalities and along lakefronts. To determine the risk of these existing septic systems, the age weighted density analysis was combined with the physical risk model (Figure A-7) to create an existing septic risk model (Figure A-8). The results of this model identify areas where clusters of old septic systems exist within high physical risk zones. This model can be used as a tool by policy makers, planners, regulatory agencies, and the public to identify areas where existing septic systems potentially pose a risk to adjacent water resources and public health.

A significant limitation of the existing septic risk model is the lack of septic system permit data prior to 1978, when permitting septic systems was initiated in Flathead County. To address this limitation, this study utilized the Cadastral database to identify parcels that likely have a septic system installed, but are not included in, the septic permit database (A-9). Over 8,000 parcels were identified through this analysis and are distributed in higher concentrations around municipalities in unincorporated areas and surrounding lakes in Flathead County. The results are a reasonable approximation of the existing scale and extent of unpermitted septic systems. 72% of households identified and surveyed in the unpermitted septic analysis confirmed the presence of a septic system on their property, providing additional confidence in the analysis (Appendix D).

This project has increased the overall understanding and spatial component of the physical and existing septic risk factors within the Flathead Basin. The physical risk model combined the individual risk factor (i.e., soils, slope, groundwater, and surface water) into a model that can be used to predict potential water quality impacts from existing and proposed development. The existing septic risk model characterizes the current threat septic systems pose to water resources in Flathead County. Application of these results should be limited to the watershed to neighborhood scale given the precision of the GIS data used as inputs. Overall, these models will allow the public, planners, regulators, and policy makers to engage in science-based decision making to protect the Flathead Basin's unique and iconic water resources.

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1 Background

Non-Point Source (NPS) pollution is derived from runoff, precipitation, drainage, atmospheric deposition, seepage, or modification of hydrology. NPS pollution is often mobilized by rainfall or snowmelt moving over and through the ground. The runoff picks up natural and human-made pollutants, depositing them into lakes, rivers, wetlands, and groundwater aquifers. NPS can include excess fertilizers, pesticides, petroleum and its derivatives, sediment, salts, as well as bacteria and nutrients from livestock and faulty septic systems. The U.S. Environmental Protection Agency (EPA) cites that NPS pollution is the leading cause of water quality degradation in the United States. These pollutants have harmful effects on drinking water supplies, recreation, fisheries, and wildlife.

Septic systems consist of a tank and a drain field that receive household effluent from toilets, sinks, showers and washing machines. Septic leachate is the liquid that remains after the wastewater solids settle in the tank. More than one in five households in the US (~21.5 million) have individual or small community septic systems. Septic systems that are properly planned, designed, sited, installed, operated, and maintained can achieve satisfactory wastewater treatment. However, systems that are sited in densities that exceed the treatment capacity of regional soils and systems that are outdated, or poorly designed, installed, operated, or maintained can cause problems. Poor drainage, surface ponding, and groundwater contamination can result. The most serious documented problems involve contamination of surface waters and ground water with disease-causing pathogens, pharmaceutical compounds, and nutrients. Excessive nitrogen and phosphorus discharges increase algal growth, nuisance aquatic plants and degrade aquatic habitat by lowering dissolved oxygen levels. The U.S. Bureau of Census indicates 10 percent of on-site systems nationwide are no longer working, with some communities reporting failure rates as high as 70 percent. Cumulatively, failing septic systems are a newly recognized and a serious risk to the nation's water resources.

In Montana, septic systems are permitted and regulated at the county level, and there are no state-wide requirements to maintain or inspect septic tanks once they are installed, or to test the efficacy of the drain field. The only exception to this is for level two systems, which are a small percentage of those permitted in the state, that do have limited inspection and monitoring requirements. Oversight and enforcement of operational requirements to keep septic systems from leaking raw waste on to the land or in to ground and surface water are deficient across much of outer suburban and rural America where most systems are installed. Federal guidelines do not address septic systems, and it is up to the states, counties, and tribes to regulate, resulting in significant variability in implementation and enforcement of standards. Montana Department of Environmental Quality (DEQ) provides standards for design, but local governments oversee the permitting and installation of septic systems.

FBC adopted a strategic plan in 2019 that focused on addressing NPS pollution issues impacting water quality in the Flathead Basin. While NPS pollution includes many different divergent sources, septic leachate is one that has been well-documented in the Flathead Basin dating back to the 1970s. Several studies have been conducted for various lakes within the Flathead Basin and these studies have verified the presence of human gut fauna and/or whitening agents in surface waters. FBC developed an On-site Wastewater Treatment Committee to take a focused approach to the issue and the committee has been working on potential approaches to better address septic leachate pollution in the basin. A priority of FBC and the committee is to better characterize the issue for the public, partners, and decision makers.

Despite studies and conclusive results, no substantial changes into policy, regulation or permitting have been made to date.

2 Introduction

The Flathead Basin Commission (FBC) retained River Design Group, Inc. (RDG) to conduct a spatial risk assessment of on-site wastewater treatment systems (septic systems) throughout Flathead County and Lake County. The two primary goals were to develop a tool to predict the effectiveness of future septic systems across the basin based on geophysical factors and to model the existing risk from septic systems already installed. The On-site Wastewater Treatment Committee identified a group of geophysical risk factors related to septic system performance and pollutant transport. These factors included slope, groundwater depth, soil treatment capacity, and distance to surface water. The physical risk factors for septic failure and underperformance were compiled from publicly available data and used to create individual maps of each risk factor and prepare models that combined all factors. The factors were analyzed for risk by assigning qualitative risk categories to quantitative data based on thresholds identified in the literature, established policy, and professional judgment.

Beginning in 1978, all new septic systems were required to obtain a permit from Flathead County prior to installation. Septic permits were compiled by Flathead County Health Department and GIS department into a spatial database. Septic systems that were installed before 1978 were not required to obtain a permit unless the system needed repair, alteration, or replacement. These septic systems are not included in the Flathead County septic permit database and posed a challenge to fully understand the spatial extent and intensity of septic leachate risk. Age is a critical risk factor for septic system failure and the systems that pre-date the permitting requirement are the oldest on the landscape. Estimating and mapping unpermitted septic systems was identified by the FBC On-site Wastewater Treatment Committee as key objectives.

The two nutrients associated with septic tank leachate that have the most influence on algae growth and water quality are nitrogen and phosphorus. Nitrogen and phosphorus are identified by DEQ as having major effects on Flathead Lake water quality, for which maximum target levels have been identified (DEQ 2014). Soil properties have a significant impact on the ability of a drain field to treat nitrogen and phosphorus from wastewater effectively. Extensive soil mapping efforts have been completed throughout Flathead County and Lake County and provide detailed information on the characteristics and spatial extents of soils (USDA 1960-2020). These data were used to determine soil suitability for the treatment of nitrogen and phosphorus and map the associated risk.

Proximity of septic systems to surface water presents a risk factor for septic leachate contamination. A short travel time from septic to the waterbody (transport time) decreases the likelihood that the soil and microbial community had sufficient time and media to properly filter the contaminants (i.e., nitrogen, phosphorous, bacteria, virus). Additionally, being closer to surface water increases the chances of flooding and interaction with shallow groundwater which both decrease effectiveness of septic treatment and allow for faster transport of pollutants to the water body. Due to these factors, Flathead County septic permit regulations limit the use of septic systems within 100 feet of surface water or FEMA 100-year floodplain (FCHD 2014).

> *Floodplain: No soil absorption system shall be located within 100 feet of a 100-year floodplain of any river, lake, stream, pond, or watercourse and any swamp or seep as delineated by the most current Federal Emergency Management Agency (FEMA) floodplain maps available and accepted for use in Flathead County…*

Shallow groundwater can reduce septic leachate treatment efficiency. When the residence time of leachate in soil is reduced, less nitrogen and phosphorous are treated and removed from the effluent. This results in larger concentrations of septic leachate contaminants into groundwater. Additionally, shallow groundwater also reduces the time it takes to mobilize contaminants into the aquifer, thus increasing risk to public health. Flathead County requires septic system permit applicants to demonstrate that the drain field has at least four feet of depth from the natural ground surface to high seasonal groundwater level (FCHD 2014).

Increased slope reduces the time the septic leachate is treated in the natural soil beneath the drain field and increases the likelihood of outflowing to the surface. Due to these factors, Flathead County septic permit regulations limit the use of septic systems in steep topography (FCHD 2014).

> *Natural slopes greater than 15% but less than 25% shall preclude the use of subsurface sewage treatment unless evidence is submitted substantiating that soil and groundwater conditions are such that there will be no visible outflow of liquid downslope from the installation of the sewage treatment system. Such material shall be submitted by an engineer, soils scientist, or geologist. Natural slopes greater than 25% will not be considered for sewage treatment system installation.*

The effects of the physical risk factors were combined to develop models of physical risks and existing septic risks for Flathead County and Lake County. This methodology was adapted from Whitter and El-Kadi (2009) that used publicly available GIS data to create septic risk maps for the island of Oahu, Hawaii. Given the geographic differences, the specific variables used in this study deviate from the 2009 study but are based on the same fundamental premises and use landscape level GIS data to better characterize risks related to on-site wastewater treatment.

3 Methods

The following sections describe the methods used in each component of risk analysis and modeling. This includes the following items:

- Existing Septic Systems
    - Septic Age Risk Analysis
    - Unpermitted Septic System Analysis
- Geophysical Risk Factors
    - Soil Treatment Risk
    - Groundwater Depth Risk
    - Surface Water Risk
    - Slope Risk
- Risk Models
    - Physical Risk Model
    - Existing Septic Risk Model

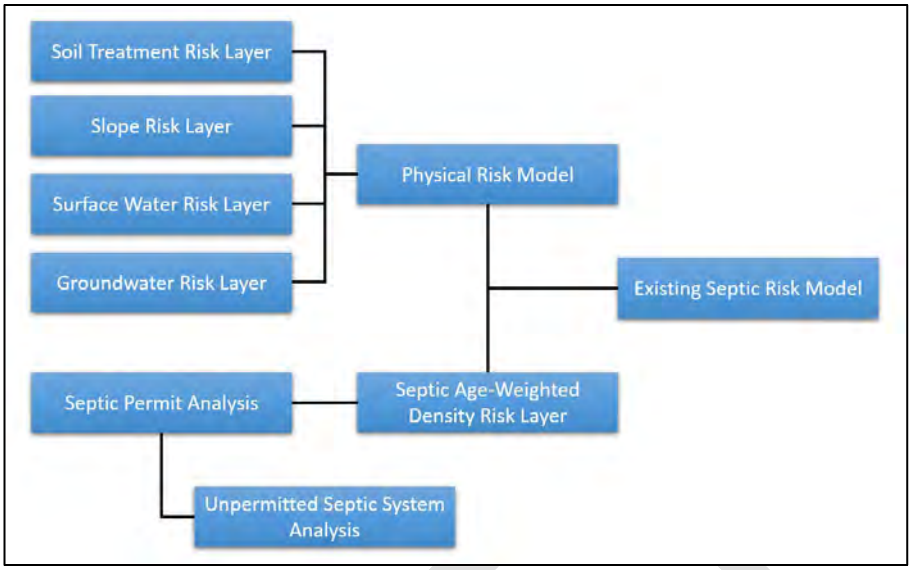


Figure 1. Project workflow and model component overview.

3.1 Existing Septic Systems

The following section describes the methods used to characterize and analyze existing septic systems in Flathead County.

3.1.1 Septic Age Risk Analysis

The Flathead County septic permit database was plotted to depict age of the permits. The spatial analysis of the septic permit database highlights trends in development over the past 50 years (Figure A-1). Septic permit ages are color-coded, with green indicating newer permits (0-10 years old) and red and orange indicating older permits (20+ years old).

Key assumptions in this analysis include the following:

- This analysis only includes permitted systems and did not account for any new unpermitted systems or unpermitted systems installed before permitting was required, being the oldest septic systems in Flathead County.
- Septic permit age equates to the age of the septic system.
- Removed septic systems would be removed from the permit database.
- Updated systems would require a new permit that would reflect the age of the new system.

Additional analyses of age and density were performed to identify the oldest and densest clusters of septic systems in Flathead County. A 500-foot buffer was applied to each septic system permit point in the database creating a circle around the point. An age-based risk value from 1-5 was applied to each circle according to the permit database (Table 1). To account for density, an overlapping spatial analysis was performed to add values of the overlapping buffers (Figure 1). The resulting cumulative values were then assigned qualitative risk ratings ranging from very low to very high (Table 1). This analysis could not be conducted for Lake County given the lack of septic permit spatial data but could be applied in the future.

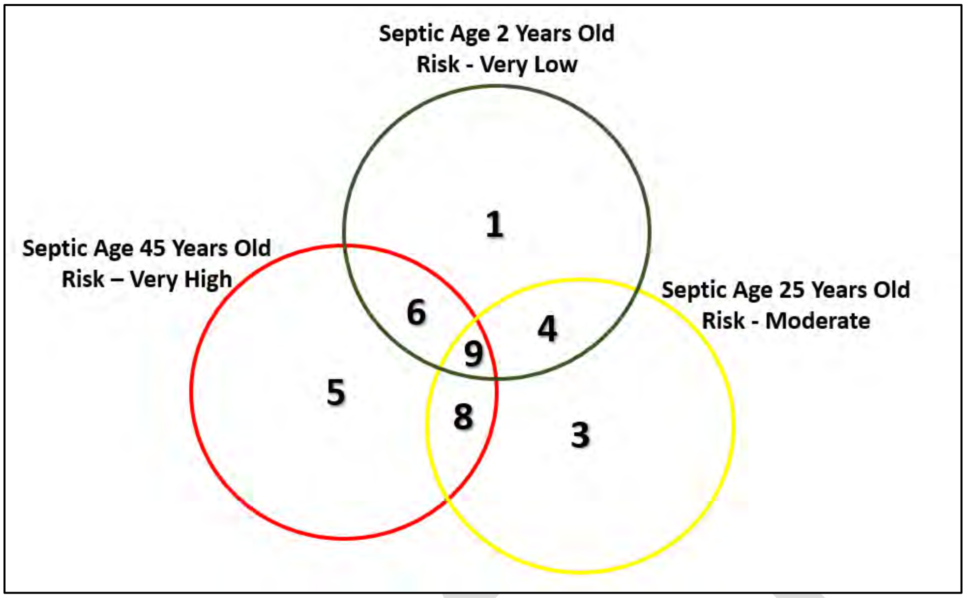


Figure 2. Example diagram of septic age weighted density analysis.

Table 1. Individual septic age risk value

Permit Age	Risk Category	Value
0 – 10	Very Low	1
11 – 20	Low	2
21 – 30	Moderate	3
31 – 40	High	4
>40	Very High	5

Table 2. Septic age weighted density risk value

Cumulative Age Value	Risk Category	Value
1 – 5	Very Low	1
6 – 10	Low	2
11 – 20	Moderate	3
21 – 40	High	4
41 - 300	Very High	5

3.1.2 Unpermitted Septic System Analysis

Given the lack of information on early development in Flathead County, proxy variables, a variable used in place of an unobservable or immeasurable variable, was used as a predictor for likely unpermitted septic systems. To identify unpermitted septic systems, the Cadastral public and private landownership database was used by applying a process of elimination. The Cadastral database provides data on ownership, structures, tax assessment value, and size for every parcel of land in Montana. The following methodology was used to eliminate parcels that were unlikely to have a septic system or had an associated permit in the Flathead County septic permit database. Thus, the remaining parcels have a high likelihood of an unpermitted septic system on the property.

- Download Cadastral database for Flathead County;
- Remove all parcels that have a septic permit in the Flathead County database;
- Remove all publicly owned and blank ownership parcels;
- Remove all parcels located within a sewer district; and
- Remove all parcels with the following tax assessment criteria:
  - Building value less than $5,000 of any acreage; and
  - Building value less than $10,000 and greater than 10 acres in size.

Key assumptions in this analysis include the following:

- Accurate and updated septic system permit data;
- Selected building value limit identified residential homes, while excluding non-residential outbuildings;
- Parcels larger than 10 acres are more likely to have outbuildings; and
- Parcels within a sewer district do not have a septic system.

A post card survey was administered to all property owners identified through the unpermitted septic system analysis. Two key questions were asked to respondents. First, is a septic system present on the identified parcel. Second, what age is the septic system if present. Responses were entered electronically and analyzed to determine the effectiveness of this screening tool.

3.2 Geophysical Risk Factors

3.2.1 Soil Treatment Risk Analysis

The soil mapping and associated soil laboratory data utilized in this report include Soil Survey of the Upper Flathead Valley Area, Montana (1960); Soil Survey of Western Flathead Valley Area, Montana (2010); Soil Survey of the Flathead Indian Reservation Wilderness Area (2019); Soil Survey of the Bob Marshall Wilderness Area, Montana (2019); Soil Survey of Lake County Area, Montana (1998); and Soil Survey of the Flathead National Forest Area, Montana (1998 and 2020). The soil suitability differentiating criteria for treatment of nitrogen and phosphorus were based upon two general soil capabilities: 1) the soil's potential to retain nutrients within the native plant's rooting zone for utilization during plant growth; and 2) the soil layers located beneath the drain field potential to chemically absorb the nutrients either in the short-term and/or long-term. The soil characteristics used for these ratings were based upon the following: 1) a literature review of soil chemistry for the two nutrients; 2) professional judgement; and 3) the availability of physical and chemical soil data from the six soil surveys (USDA 1960-2020). A sensitivity analysis was performed by selecting soils that were confidently either low or high risk and evaluating what quantitative break exists between the soil characteristics. The results determined the grouping criteria for each soil characteristic (Table 3 and Table 4). Soil types from the six survey areas were classified based on the two suitability ratings. A small group of soil types had high and low ratings split and professional judgment was used to place each in either the high or low risk group. These soil types are noted with an asterisk in Appendix C.

A key assumption in this analysis is the accuracy of USDA soil survey mapping data.

A complete list of soil map units and associated risks is included in Appendix C.

Table 3. Soil suitability: Nitrogen

Risk	Low	High
Texture	Finer than loamy sands	sands and loamy sands
% Fragments	<30%	>30% or lithic
Cation Exchange Capacity (CEC)	Median >10	Median <10
Saturated Hydraulic Conductivity	<42 micro mil/sec	>42 micro mil/sec

Table 4. Soil suitability: Phosphorus

Risk	Low	High
% $CaCO_3$	≥7.5% in subsoil	<7.5% in subsoil
% Fragments	<60% in subsoil	>60% in subsoil or lithic
Texture	Finer than loamy sands	Sands and loamy sands

3.2.2 Groundwater Depth Risk Analysis

To incorporate groundwater depth into the risk analysis, groundwater depth layers for both counties were created using The Ground Water Information Center (GWIC) data. Researchers at Flathead Lake Biological Station created a groundwater map of the Flathead Valley using existing well data from Montana's Ground Water Information Center (FLBS 2018). The analysis interpolated a groundwater surface between wells' static water level. The water level was then compared to the ground surface to determine the water depth below ground (i.e., ground elevation minus groundwater surface elevation). A digital groundwater depth map was not available for Lake County. This study incorporated a potentiometric surface map (hard copy) created by Montana Bureau of Mines and Geology (2004). The map was geo-referenced, groundwater contours were digitized, and a digital surface was created from this data. The groundwater elevation surface was then subtracted from the 30-meter Digital Elevation Model (DEM) to create a groundwater depth layer. Three qualitative risk categories (e.g., low, moderate, and high) were assigned to groundwater depths from 0-feet to greater than 20-feet (Table 5).

Key assumptions included:

- The static water level surface is suitable for countywide risk assessment;
- Well density is adequate throughout study area for landscape level analysis;
- Seasonal variability is not captured in this data; and
- Uncertainty in DEM and groundwater depth layer.

Table 5. Groundwater depth risk

Depth (ft)	Risk Category
< 10	High
10 - 15	Moderate
15 - 20	Low
> 20	-

3.2.3 Surface Water Risk Analysis

Surface water data from the National Hydrography Dataset (NHD) was used for this analysis. All surface water bodies in the NHD were used to create a series of buffers ranging from high to low-risk distances. Table 6 summarizes the distances assigned to the range of risk categories. These values were established based on DEQs Total Mean Daily Load (TMDL) analysis for nitrogen and phosphorous loading for the Flathead River watershed (DEQ 2014).

Key assumptions in this analysis include:

- The NHD is an accurate and complete inventory of surface waters; and
- Distances developed for nitrogen and phosphorous modeling by DEQ are accurate representations of risk levels.

Table 6. Surface water risk

Distance to Surface Water (ft)	Risk Category
0 – 100	High
100 – 500	Moderate
500 - 5000	Low

3.2.4 Slope Risk Analysis

The slope was calculated using a 30-meter Digital Elevation Model (DEM). The risk categories were based on the thresholds established by the Flathead County Health Department (Table 7). Slopes less than 10% were determined to have no risk and excluded from the analysis. Slopes greater that 60% were determined not suitable for construction and excluded from the analysis.

Key assumptions in this analysis include the following:

- 30-meter resolution is suitable for countywide risk assessment;
- Slope ranges are accurate representations of risk levels; and
- No development occurs on slopes greater than 60%.

Table 7. Slope risk

Slope (%)	Risk Category
0 - 10	-
10 - 15	Low
15 - 25	Moderate
25 - 60	High
> 60	-

3.3 Risk Models

3.3.1 Physical Risk Model

The physical risk model was created by combining the individual risk factors described in Section 3.2 into a cumulative model. Each factor was weighted equally with values assigned to each risk independently (Table 8). The values of the individual layers were summed together, creating a single raster layer with values ranging from zero to 15. The equation below summarizes the variables used.

$$G_w + S_w + M + N_r + P_r = R_P$$

G_w – Groundwater depth risk value
S_w – Surface water risk value
M – Slope risk value
N_r – Nitrogen soil treatment risk value
P_r – Phosphorous soil treatment risk value
R_P – Physical risk value (cumulative)

Risk categories from very low to very high were assigned for the cumulative risk using the following rationale. Very low risk was assigned for locations that have no risk factors or low risk in a single risk factor. Very high risk was assigned for locations with at least three risk factors and at least one high risk factor. Septic system failure or underperformance often includes multiple factors compounding at a site and the risk categories aim to mirror this. The more risk factors present at a location the higher the physical risk model results. The cumulative risk rating categories for the final physical risk model are summarized in Table 9.

Key assumptions included:

- Equal weighting of risk factors is appropriate;
- The risk category values are reflective of true risk on the ground; and
- All assumptions associated with each layer.

Table 8. Physical risk model (components)

Feature	Category	Value
Nitrogen Risk (Soil)	Low	0
Nitrogen Risk (Soil)	High	3
Phosphorus Risk (Soil)	Low	0
Phosphorus Risk (Soil)	High	3
Groundwater < 10'	High	3
Groundwater 10' - 15'	Moderate	2
Groundwater 15' - 20'	Low	1
Groundwater > 20'	-	0
Slope (%) 0 - 10	-	0
Slope (%) 10 - 15	Low	1
Slope (%) 15 - 25	Moderate	2

Slope (%) 25 - 60	High	3
Slope (%) 60 - 90	-	0
Surface Water 500' – 5000'	Low	1
Surface Water 100' – 500'	Moderate	2
Surface Water 0' – 100'	High	3

Table 9. Physical risk model (cumulative)

Risk Category	Value
Very Low	0 - 1
Low	2
Moderate	3 - 4
High	5 - 6
Very High	7 - 15

3.3.2 Existing Septic Risk Model

This study developed a model that merges the septic age weighted density analysis with the physical risk model to expand the physical risk model to represent the existing risk associated with septic systems on the landscape. The value from the physical risk model, summation of all physical risk layers, was multiplied by the septic age weighted density value. The equation below summarizes the variables used. An example diagram depicting a hypothetical modeling situation is presented in Figure 2.

$$R_P \times S_r = E_r$$

R_P – Physical risk value (cumulative)
S_r – Septic age weighted density risk value
E_r – Existing septic risk value

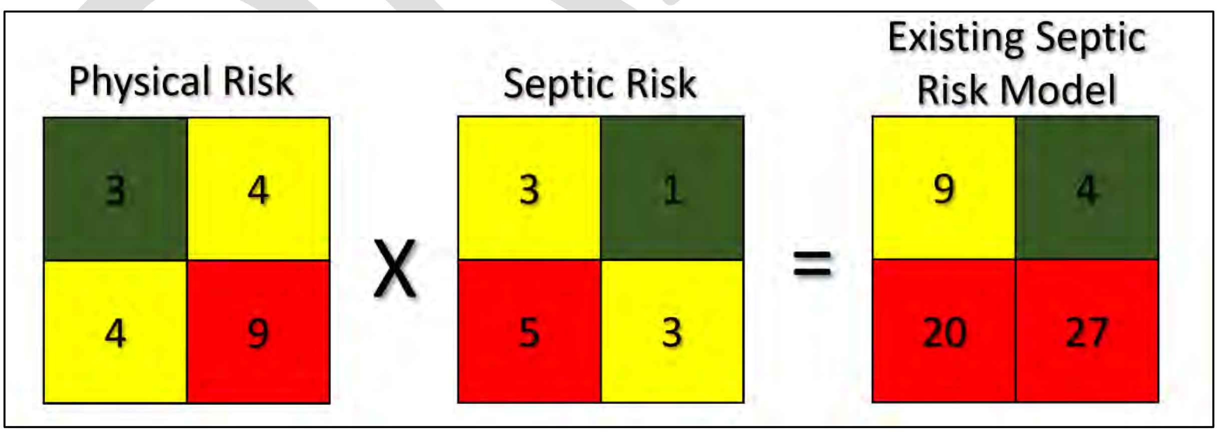


Figure 3. Example diagram of existing septic risk model components and results.

The results from this model were assigned risk categories from very low to very high (Table 10). The divisions between categories were adjusted qualitatively by evaluating the distribution and frequency of each category in the model. Efforts were made to ensure that the highest risk locations stand out from the low and moderate risk zones. Additionally, validation sites of known septic risk were used to help calibrate the results and ensure modeled risk categories align with real world conditions.

Table 10. Existing septic risk model

Risk Category	Value
Very Low	0 – 2
Low	2 – 5
Moderate	5 – 10
High	10 – 15
Very High	15 – 65

Key assumptions included:

- Equal weighting of physical risk and septic age weighted density is appropriate;
- The multiplication of physical risk and septic risk (a linear relationship) is appropriate;
- The risk category values are reflective of true risk on the ground; and
- All assumptions associated with each physical risk layer.

4 Results

The following sections describe the results of each analysis and model.

4.1 Septic Age Risk

The septic permit geodatabase provided by Flathead County Health Department (FCHD) was used to map 21,415 septic permit locations and provide analysis on the age of the systems (FCHD 2020). Over half of the existing systems in Flathead County are older than 20 years and pose a moderate to extreme risk (Figure 3). As these systems continue to age, the number of high and extreme risk systems on the landscape will double in the next decade. While the number of septic permits issued per year varied between 300 and 800 based on economic conditions, an average of 400 per year could be assumed over a decade (Figure 4). Despite growing population trends for Flathead County, the peak of issued permits in the 2010s was only 500 per year compared to the peak in the 1990s and 2000s of around 750 to 800 permits. Recent development and growth may outpace the current trend and lead to an increase in annual permits issued.

Permits of a similar age are clustered together with the oldest clusters typically located around existing municipalities and lakefronts. More recent permits are dispersed throughout the county in rural areas, except for a cluster in lower valley south of Church Slough. Development outside of the valley floor is concentrated along surface water bodies, both lakes and streams. Overall, the spatial trends in this analysis are useful tools for understanding the distribution of septic systems on the landscape and their risk relative based on age. This analysis could not be conducted for Lake County given the lack of septic permit spatial data but could be applied in the future.

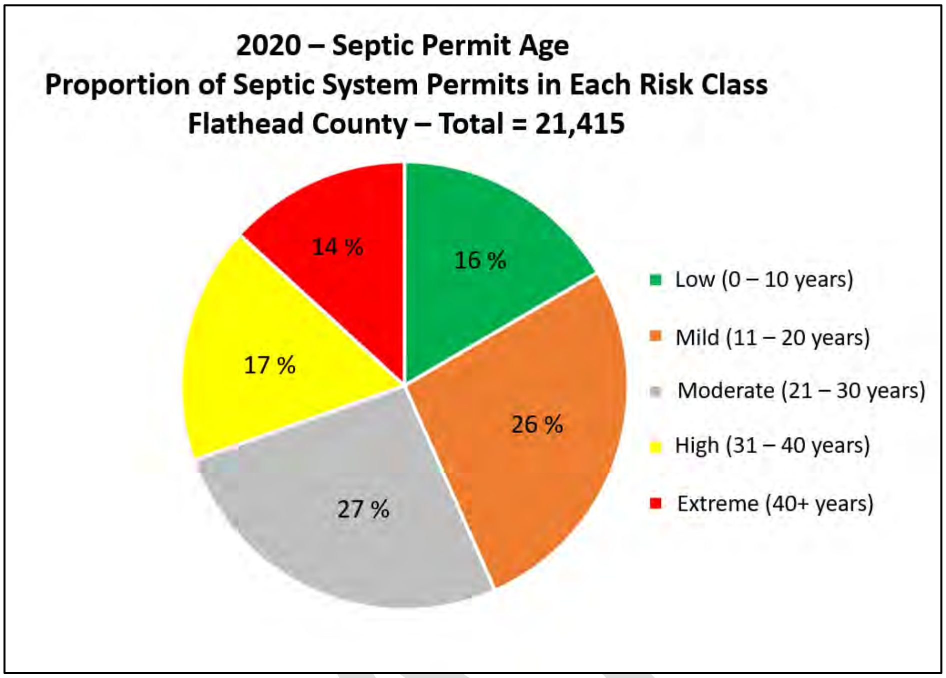


Figure 4. Proportion of septic system permit ages in Flathead County.

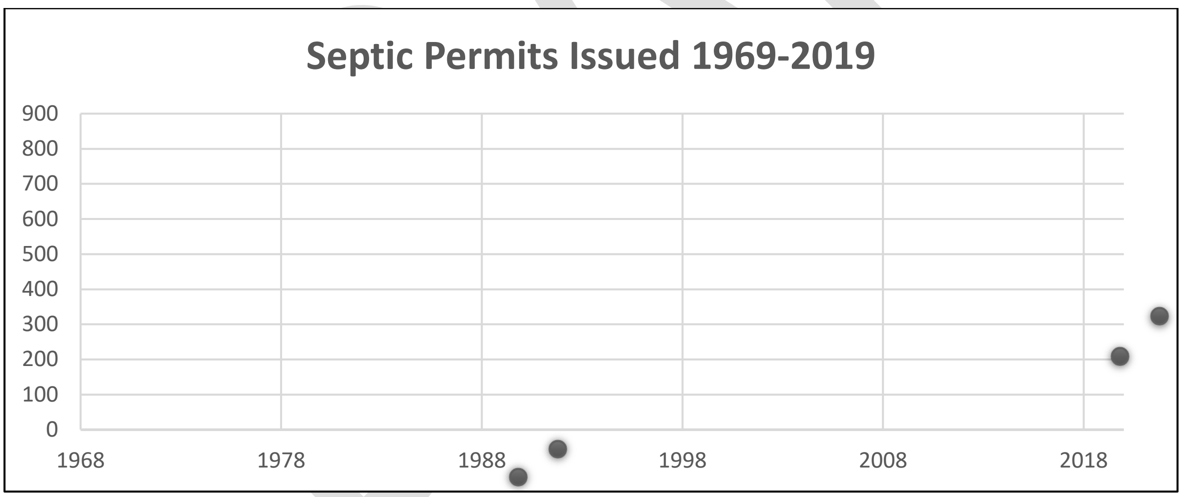


Figure 5. Septic permits issued by year from 1969-2019 for Flathead County.

The resulting map from the septic age weighted density analysis is shown in Figure A-2. The mapping effort revealed the following trends. The oldest and densest zones are in older subdivisions located outside of city limits. Rural development is disperse enough to limit scores despite the age of the system. High risk zones are more common near the boundary of a municipality.

- Example areas include the following:
  - Suburban development surrounding Kalispell;
  - Suburban development surrounding Whitefish;

- Development throughout Hungry Horse; and
- Suburban development surrounding Lakeside.

4.2 Unpermitted Septic Systems

Over 8,000 parcels were identified through this analysis as likely having an unpermitted septic system on the property (Figure A-9). These parcels are widely distributed throughout Flathead County in both rural and urban development. The highest densities of identified parcels occur in un-incorporated urban and sub-urban centers. The lowest densities of identified parcels are within municipal boundaries and sewer districts. The authors recognize the level of uncertainty presented in this analysis but support the results as a first-order approximation of unpermitted septic systems frequency and distribution in Flathead County. It is important to note that the presence of unpermitted septic system does not imply any wrongdoing by the existing or previous landowners. Septic systems installed prior to 1978 were "grandfathered" and are not required to apply for a permit unless repair, alteration, or replacement of the system is warranted.

The survey administered to the 7,747 property owners identified in the analysis recorded 192 unique responses, approximately 2.5% response rate. 72% of respondents confirmed the presence of a septic system on the parcel identified in the analysis. The results identified a false positive rate of 26% for the analysis. This equates to roughly 2,000 false positives of the 8,000 parcels identified as having an unpermitted septic system. These results confirm the applicability of the analysis as an initial screening tool to understand the extent and scale of unpermitted septic systems in Flathead County. For further results and discussion refer to Appendix D.

4.3 Soil Treatment Risk

The results from the soil treatment risk analysis depict the high-risk areas for treatment of nitrogen and phosphorous. Results for Flathead County and Lake County are presented in Figure A-3 and Figure B-1, respectively. Soils are more likely to have high risk for soil treatment of nitrogen and phosphorous together than independent. High risk for only phosphorous treatment is more prevalent than only nitrogen treatment risk. In Flathead County, high risk for soil treatment of nitrogen and phosphorous accounts for a majority of the valley floor. Hillslopes surrounding the valley in Flathead County exhibit minimal soil treatment risk. High risk nitrogen treatment zones are dispersed throughout Flathead County, while high risk phosphorus treatment zones are limited to the Ashely Creek and Foys Lake watersheds. Lake County differs from Flathead County with a much lower fraction of developable land rated high risk for soil treatment. The valley floor of Lake County has limited high risk zones for nitrogen or phosphorous treatment, with a notable exception between Polson and Pablo. Hillslopes in Lake County have high risk treatment zones for nitrogen and phosphorous surrounding Flathead Lake, Lake Mary Ronan, and Swan Lake. The Swan River valley is dominated by high-risk phosphorous treatment zones with additional nitrogen and phosphorous high risk treatment zones intermixed. High risk for soil treatment of phosphorous only are limited to very small, rare areas making it difficult to detect at the county scale. Overall, soil treatment risk is a more significant contributor to overall septic risk in Flathead County compared to Lake County.

4.4 Groundwater Depth Risk

Groundwater depth risk maps for Flathead County and Lake County (Figures A-4 and B-2) depict the range of risk, low to high, related to modeled depth to groundwater from existing well data. Flathead County and Lake County both have large high-risk zones consolidated around rivers and creeks in the valley floor. In Flathead County, a large consolidated high-risk area is concentrated around the Flathead River in the center of the valley and expands in extent near Flathead Lake. Additional high-risk areas are relatively small and dispersed throughout Flathead County and typically associated with a surface water body. In Lake County, high risk areas are consolidated into large units but distributed throughout the county. The vast majority of shallow ground water zones are linked to fluvial surface water bodies including the Flathead River, Swan River, Jocko River, Ronan Creek, Post Creek, and Mud Creek. Nearly the entire valley bottom in the Swan River valley is rated as high risk, with the extent of the risk increasing in proximity to Swan Lake. Both Flathead County and Lake County groundwater depth risk zones exhibit a steep gradient from high to low risk, with most of the risk being high. Overall, groundwater risk in both counties is closely linked to surface water bodies and overlaps with existing urban and rural development.

4.5 Surface Water Risk

The resulting maps from the surface water risk analysis depict the range of risk related to distance to surface water. Maps for Flathead County and Lake County are included in Figure A-5 and Figure B-3, respectively. Large scale trends are similar between the counties with low risk being widespread, but high-risk zones being limited in spatial extent. The majority of risk associated with surface water in Flathead County results from rivers, creeks, and streams. A concentration of moderate to high-risk zones are found in the central portion of the valley adjacent to Flathead River and its tributaries, which converge east of Kalispell. With a lower drainage density, Lake County differs from Flathead County, with the majority of surface water risk being associated with lakes, ponds, and wetlands. A concentration of moderate to high-risk zones exist south of Ronan where there is a high concentration of small ponds and ephemeral wetlands. Both counties have widespread low risk and concentrated areas of moderate to high risk related to surface water.

4.6 Slope Risk

Slope risk maps for Flathead County and Lake County depict the range of risk, low to high, related to topographic slope (Figure A-6 and B-4). Slope risk is largely associated with hillslopes and mountains surrounding the valley for both Flathead County and Lake County. While most of these hillslopes are not areas where development has occurred, notable exceptions are adjacent to lakes in both counties. Development around Whitefish Lake, Echo Lake, and Flathead Lake are in slope risk zones ranging from low to high for Flathead County. In Lake County, development occurs around Swan Lake, Lake Mary Ronan, and Flathead Lake in low to high-risk zones. The valley floors in both counties are largely free of slope risk; however, river terraces and glacial landforms present small, localized risks, especially surrounding Flathead River, and its tributaries in the valley floor. Overall, slope risk is relatively limited to hillslopes adjacent to lakes where development is older and denser.

4.7 Physical Risk Model

The physical risk model identified low to very high risk for septic system effectiveness based on the cumulative effects of soil treatment, slope, groundwater depth, and proximity to surface water. Results for Flathead County and Lake County are included in Figure A-7 and Figure B-5, respectively. In Flathead County, very high and high-risk zones are concentrated on the valley floor in the center of the valley and surrounding Echo Lake. Hillslopes surrounding the valley exhibit low to moderate risk, with exceptions west of Lakeside and south of Ashely Creek. Lands between the Flathead River and Whitefish River south of Highway 40 are predominately very high risk and have higher levels of development. The Lost Creek alluvial fan, west of Kalispell, rated high risk and has documented nitrate contamination in the groundwater (Alvey 2007). Soil treatment and groundwater depth are the most linked variables to very high and high-risk results. Other notable very high-risk zones include:

- South end of Whitefish Lake;
- Areas surrounding Hungry Horse and Martin City;
- West Glacier and surrounding areas south of Middle Fork Flathead River; and
- Bigfork and surrounding areas.

In Lake County, very high and high-risk zones are more dispersed and prevalent in the surrounding hillslopes than the valley floor. The majority of the valley floor from Polson to St. Ignatius does not pose a significant physical risk for septic system treatment. Notable exceptions include Pablo and land adjacent to the Flathead River, Ronan Creek, Post Creek, and Mud Creek which rated as very high to moderate risk. Much of the land surrounding Flathead Lake is rated very high to moderate risk including the following notable sites:

- Eastern lakeshore from Woods Bay to Polson;
- Finley Point;
- Kings Point;
- Cromwell and Wild Horse Island; and
- Dayton.

Additionally, hillslopes surrounding Lake Mary Ronan rate very high to high risk and is a known site where algae blooms are present and likely linked to septic leachate. Outside of the Flathead Valley floor in Lake County very high to high risk is more prevalent. The entire valley floor in the Swan River and Jocko River valleys rated very high to moderate risk. Soil treatment risk and groundwater depth are most linked to the very high and high risk in the valley floor, while slope and soil treatment risk link to very high and high ratings on the hillslopes.

4.8 Existing Septic Risk Model

The model results identified areas with very high risk throughout Flathead County but limited in extent to small clusters (Figure A-8). The highest risk zones are older higher density developments located in moderate to very high physical risk zones. These include unincorporated developed areas, including areas surrounding existing cities, where very high-risk clusters were more prevalent. The clusters result in very high age weighted septic risk values due to the high density of older systems. High soil risk and shallow ground water multiply these effects in the model resulting in very high-risk zones. Significant clusters exist in the center of the valley east of Kalispell extending north to Columbia Falls. Very high-risk clusters are more frequent in areas surrounding the Flathead River, Flathead Lake, Echo Lake, Lake Blaine, and Whitefish Lake due to higher levels of development and high physical risks including soil and groundwater. Rural development resulted in moderate risk despite very high physical risk highlighting the role that density plays in the analysis. Overall, areas with higher physical risk and higher age weighted density values resulted in very high risk in the model. Areas with higher physical risk and lower age weighted density resulted in moderate risk in the model. However, areas with moderate physical risk and higher age weighted density values also resulted in very high risk in the model.

5 Discussion

The resulting analyses and mapping provide an applicable set of tools for the public, planners, regulators, developers, and policy makers to better understand the complex and compounding nature of non-point source septic system pollution. However, each map and model was designed to be applied in a specific manner that acknowledges the uncertainty of the results. The goal of this project was to address the lack of spatial understanding of potential septic leachate pollution at the watershed scale, which has been accomplished. Application at the watershed scale is appropriate and justifiable, but the uncertainty and precision of each layer limits the modeling results' confidence at a finer scale. The authors feel that application at the neighborhood scale (> 50 acres) is the finest resolution justifiable for the results. Future validation and more precise datasets could refine the results to the sub-neighborhood (< 50 acres) resolution.

The goal of the physical risk model was to characterize the physical factors that increase the risk of a septic system to fail or underperform, resulting in potential contamination of groundwater and surface water resources. The results of this model provide insight into why specific areas in the two counties, may have more septic system problems than others. The most appropriate application of the physical risk model is as a planning tool for future development and installation of septic systems. Planners, policy makers, and the public can use this model to perform an initial estimate of proposed development impacts to water quality. Often the anticipated water quality impacts of a development of sub-division project are poorly understood and cumbersome for the stakeholders to discuss using science based rational. This model will allow for more informed discussions regarding the risks of these projects to water quality based on the complex geophysical risk factors present. These results should be followed up with additional site-specific investigations for verification and not solely used for decision making. Overall, the physical risk model is a powerful tool to help drive informed conversations around non-point source pollution in the Flathead Basin.

The goal of the existing septic risk model was to document the risk of existing septic systems and their potential impact to water quality. The results from this model provide the public, planners, and policy makers insight into what is happening now. The appropriate application of the existing septic risk model is as a prioritization tool for addressing existing water quality problems or a tool to guide where further investigation into potential contaminants is needed. Resources for addressing non-point source pollution are limited, thus a tool to evaluate potential risk reduction is critical for maximizing benefits of funding applied. Uncertainty in the model is a result of the uncertainty and precision in each layer of data applied. At the watershed to neighborhood scale, this model is an applicable tool, however additional field data should be considered to validate these results in the future. Evidence from previous studies of septic leachate provide an initial source of confidence in the model (WLI 2012 and Alvey 2007). Known areas of non-point source nutrients, including Lost Creek alluvial fan west of Kalispell, and developments around Whitefish Lake and Flathead Lake, are modeled as high and very high-risk zones. Future studies and additional GIS data could allow for a more robust model to refine the results and increase confidence in the model.

6 Conclusion

This project has increased the overall understanding and spatial component of the physical and existing septic risk factors within the Flathead Basin. The physical risk model combined the individual risk factor (soils, slope, groundwater, and surface water) into a model that can be used to predict water quality impacts from new and existing development. The existing septic risk model characterizes the current threat septic systems pose to water resources in Flathead County. Appropriate application of the models is limited to the landscape to neighborhood level resolution. Additional GIS data at higher resolutions and precision could, in the future, allow users to apply at finer resolutions. Validation of these results with future investigations and supplemental site investigations will increase the overall confidence in the modeled results. These models will allow the public, planners, regulators, and policy makers to engage in science-based decision making to protect the Flathead Basin's unique and iconic water resources.

7 References

Alvey, L. 2007. Report of Findings for the Lost Creek Fan Nitrate Investigation August-September 2006. Groundwater Remediation Program Site Response Section Remediation Division. Montana Department of Environmental Quality

Bohn, H. L., B. L. McNeal and G. A. Conner. 1979. Soil chemistry. Chapter 10.

Buckman, H. O. and N. C. Brady. 1969. The nature and properties of soils. Seventh edition. Chapters 9, 16 and 17.

Department of Environmental Quality. 2014. Flathead – Stillwater planning area nutrient, sediment, and temperature TMDLs and water quality improvement plan.

Flathead Lake Biological Station. 2018. Flathead valley groundwater depth GIS layer.

Flathead County Health Department. 2014. Regulations for on-site wastewater sewage treatment systems.

Flathead County Health Department. 2020. Septic permit database.

Jourdonnais, J.H. and J.A. Stanford. 1985. Verification of shoreline sewage leachates in Flathead Lake, Montana. Montana Water Resources Research Center, Montana State University.

LaFave, John. 2004. Montana Bureau of Mines and Geology. Potentiometric surface map of the southern part of the Flathead Lake area, Lake, Sanders, and Missoula counties, Montana.

Lombardo, P. 2006. Phosphorus geochemistry in septic tanks, soil absorption systems, and groundwater.

Hinrich Bohn, Brian McNeal, and George O'Connor. 1979. Soil Chemistry. Pages 284-291.

Manahan, S. E. 1972. Environmental chemistry. Chapter 10.

Montana Forest Service. 1997. Phosphorous isotherm.

Robertson, W. D., S.L. Schiff and C.J. Ptacek. 1998. Review of phosphate mobility and persistence in 10 septic system plumes. Ground Water. V. 36., No. 6.

Stanley Manahan. 1972. Environmental Chemistry. Pages 275-276.

USDA. 1960. Soil Survey Upper Flathead Valley Area, Montana.

USDA. 1982. Summary of the Soil Chemical and Physical Analysis Data for the Flathead National Forest.

USDA. 1998. Soil Survey Flathead National Forest Area, Montana.

USDA.1998. Soil Survey of Lake County Area, Montana.

USDA. 2010. Soil Survey of the West Flathead Valley Area, Montana.

USDA. 2019. Soil Survey of the Flathead Indian Reservation Wilderness Area, Montana.

USDA. 2019. Soil Survey of the Bob Marshall Wilderness Area, Montana.

USDA. 2020. Soil Survey Flathead National Forest Area, Montana.

Whitefish Lake Institute. 2012. Investigation of septic leachate to the shoreline area of Whitefish Lake, Montana.

Whitter, Robert B., and Aly I. El-Kadhi. 2009. Human and environmental risk ranking of on-site sewage disposal systems. State of Hawai'i Department of Health.

APPENDIX A

FLATHEAD COUNTY MAPS

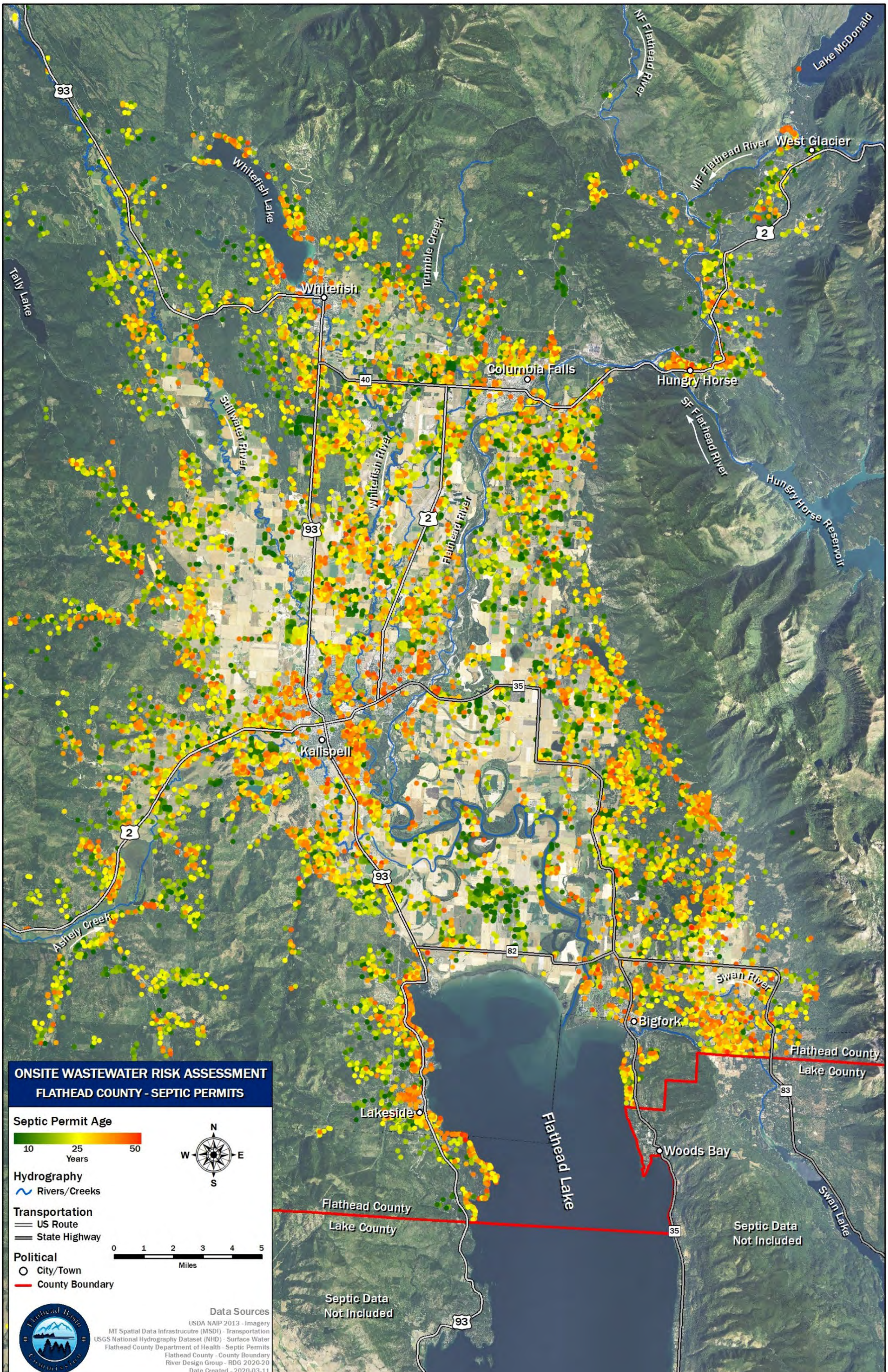


Figure A-6. Flathead County Septic Permit database color coded by age. Warmer colors indicate older systems. Unpermitted systems not included.

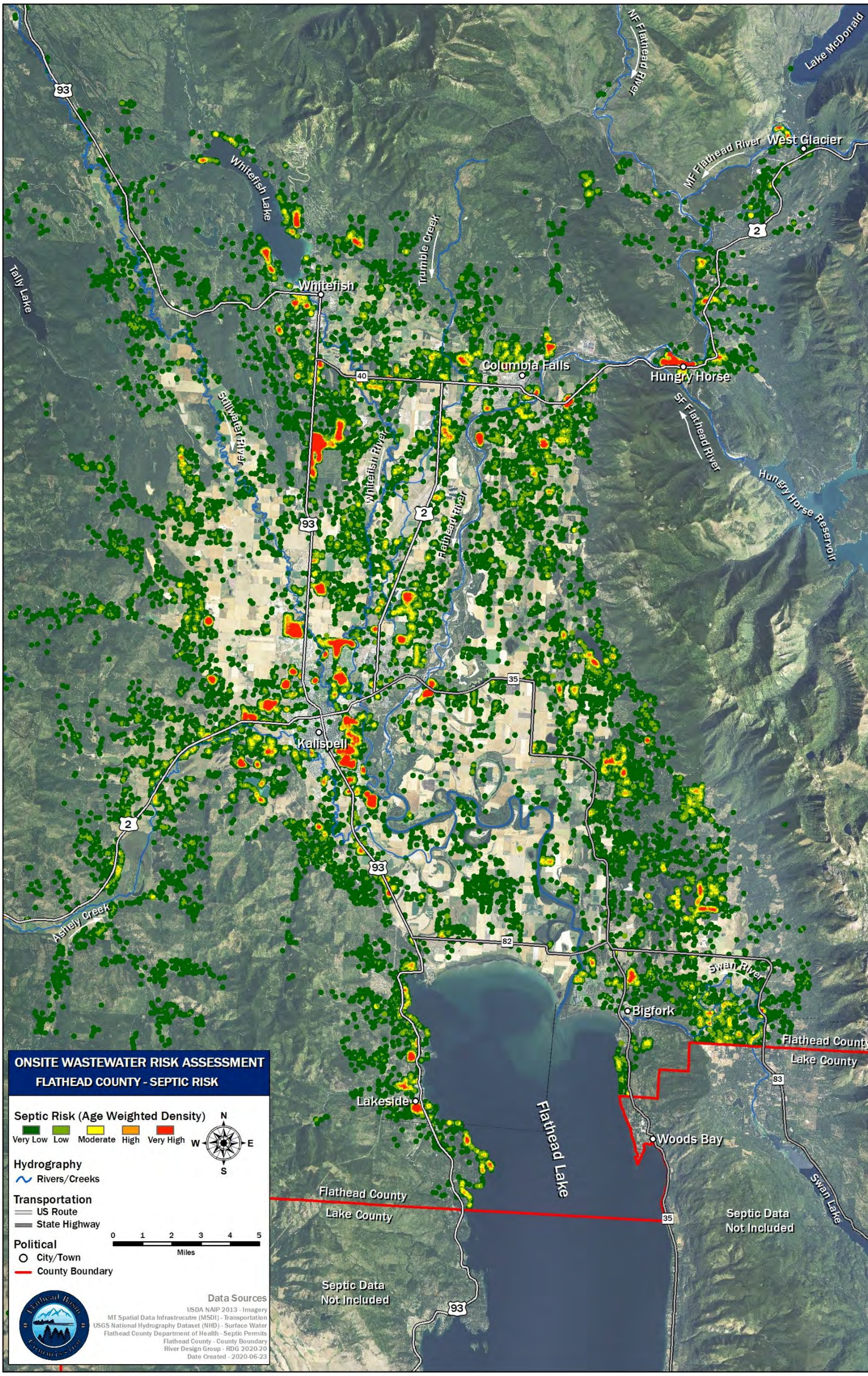


Figure A-7. Age weighted septic system density map based on Flathead County Septic Permit database. Warmer colors indicate higher densities of older systems.

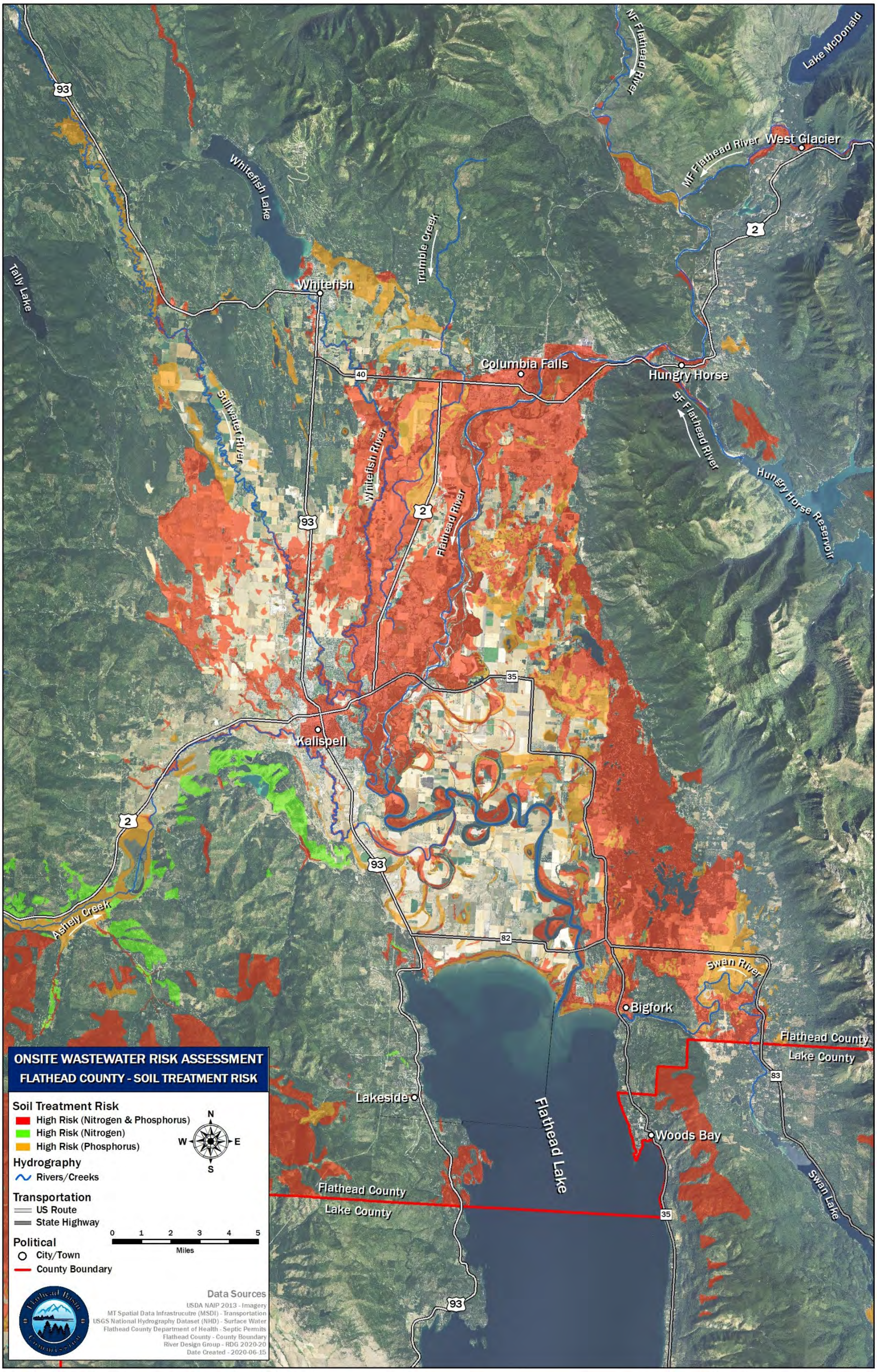


Figure A-8. Soil treatment risk map for phosphorous and nitrogen contimants from septic systems.

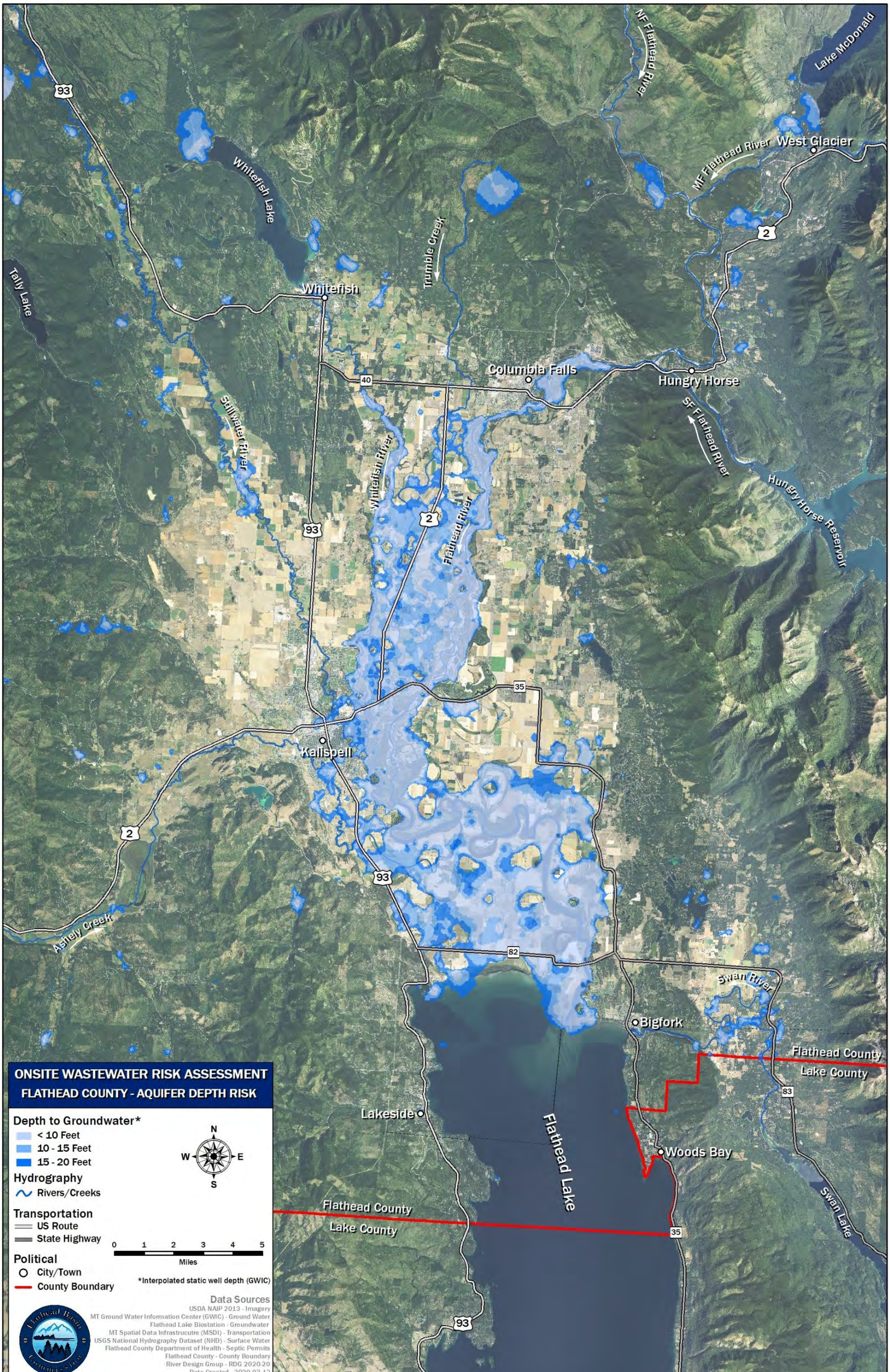


Figure A-9. Aquifer depth risk map with lighter blue areas having the shallowest groundwater and darker blue being deeper. Areas with no features indicate depths greater than 20 feet or lack of data.

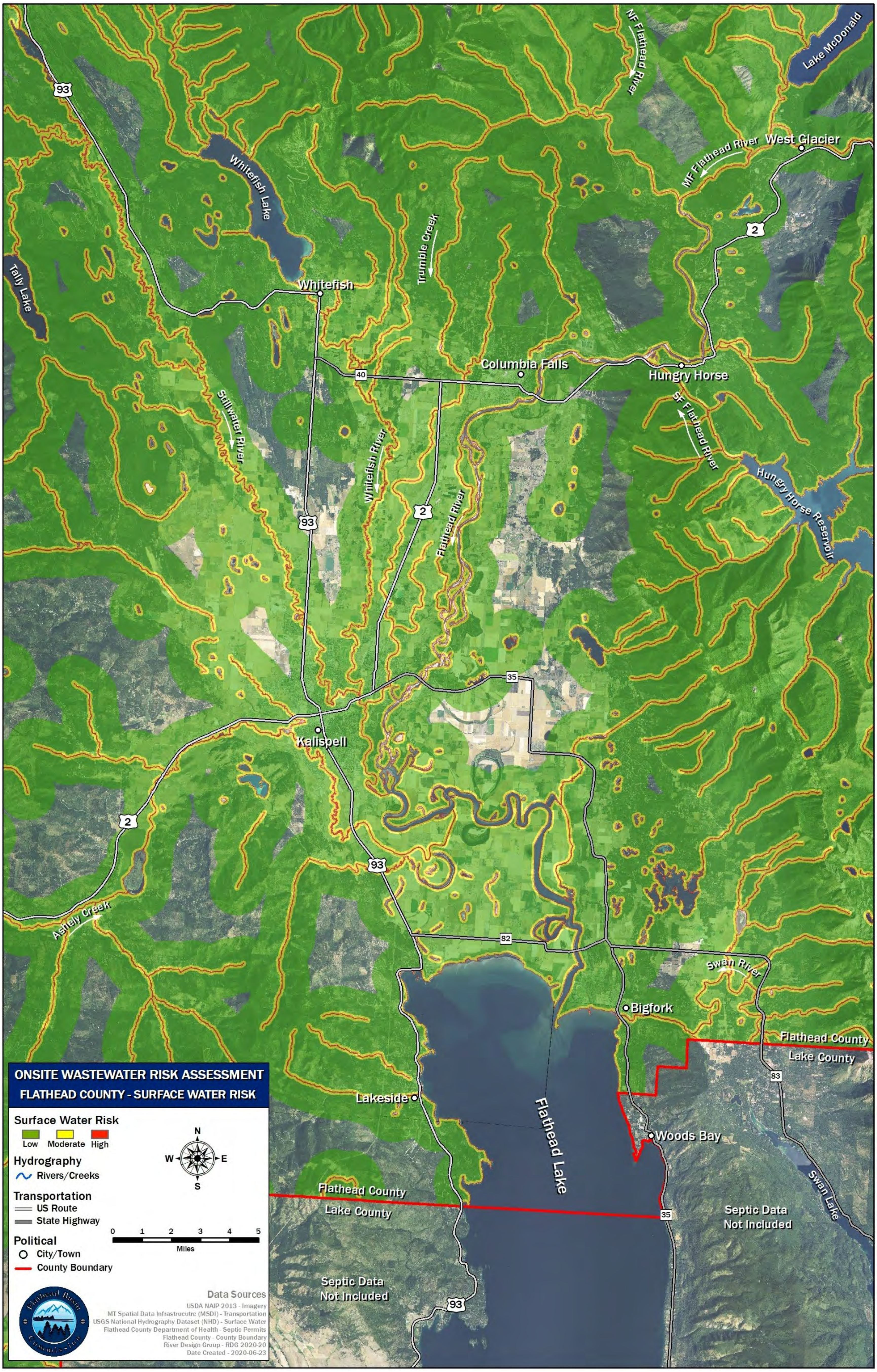


Figure A-10. Surface water risk map based on the distance from a water body (river, lakes, and streams).

Figure A-11. Slope risk map for septic treatment. Areas in red would not be feasible for septic systems, while areas in yellow and orange could support septic at a higher risk.

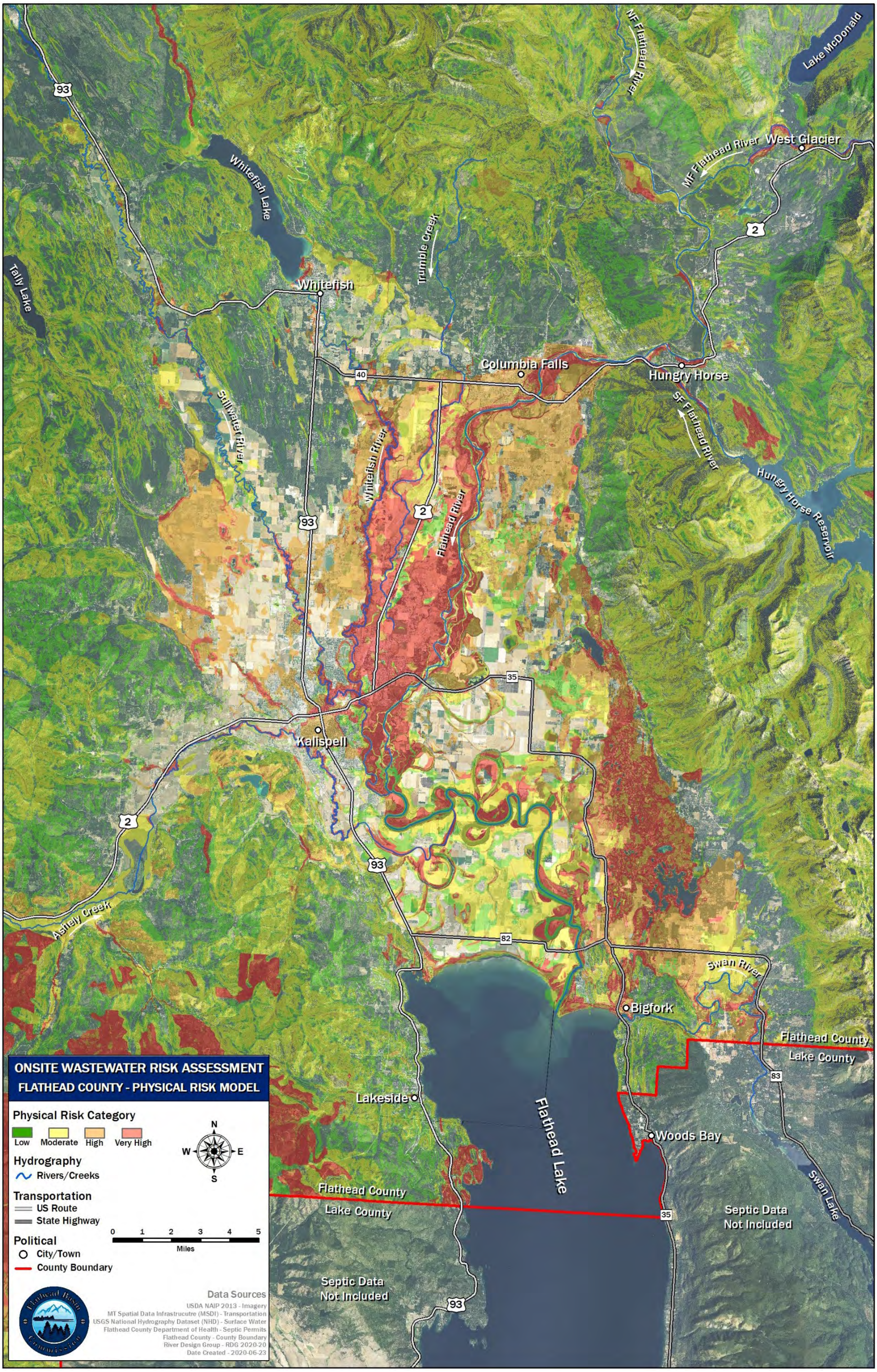


Figure A-12. Physical risk model map with areas at higher risk with warmer colors. Areas with very low risk are not shaded.

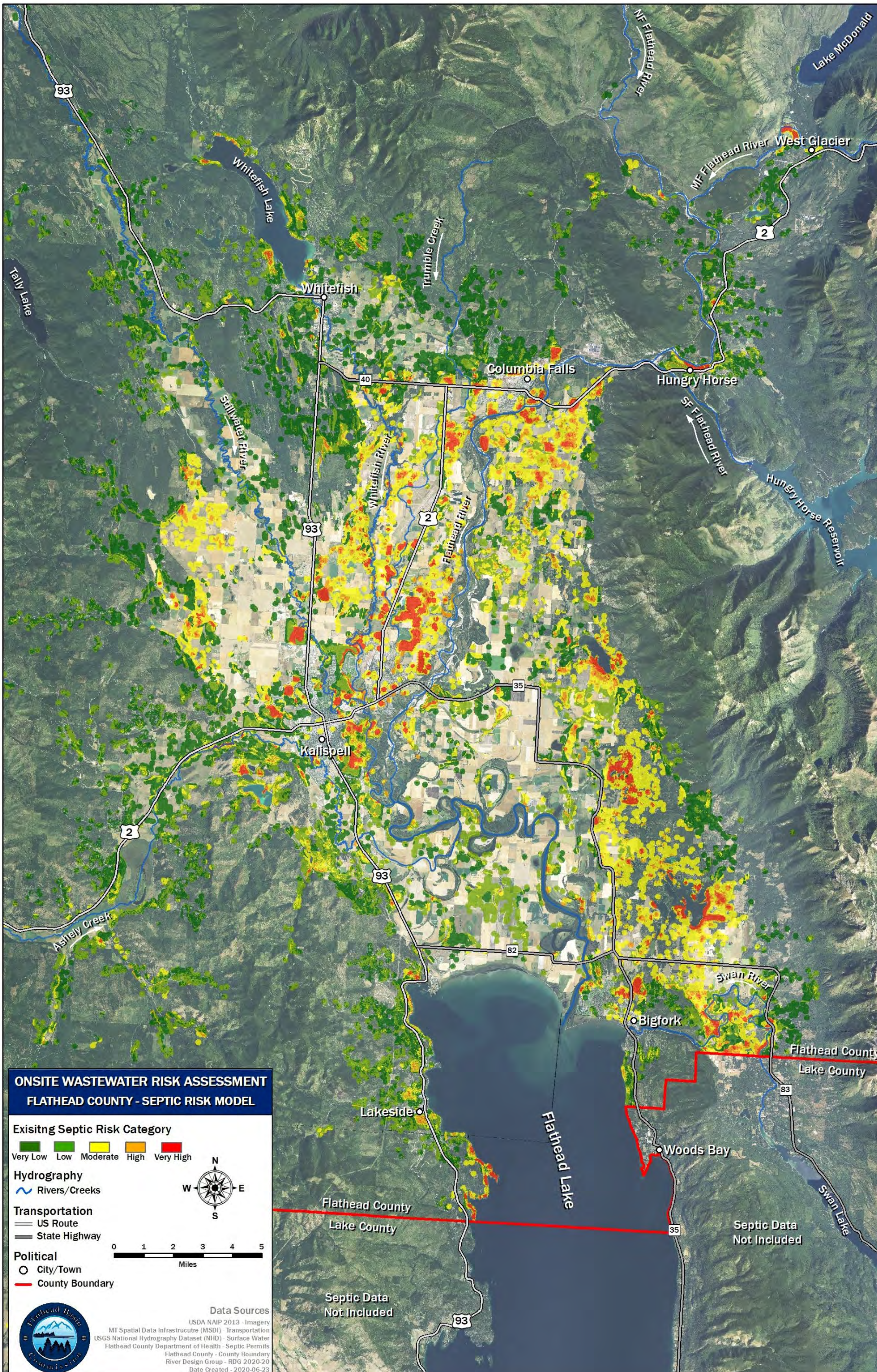


Figure A-13. Existing septic risk model map with areas at higher risk with warmer colors.

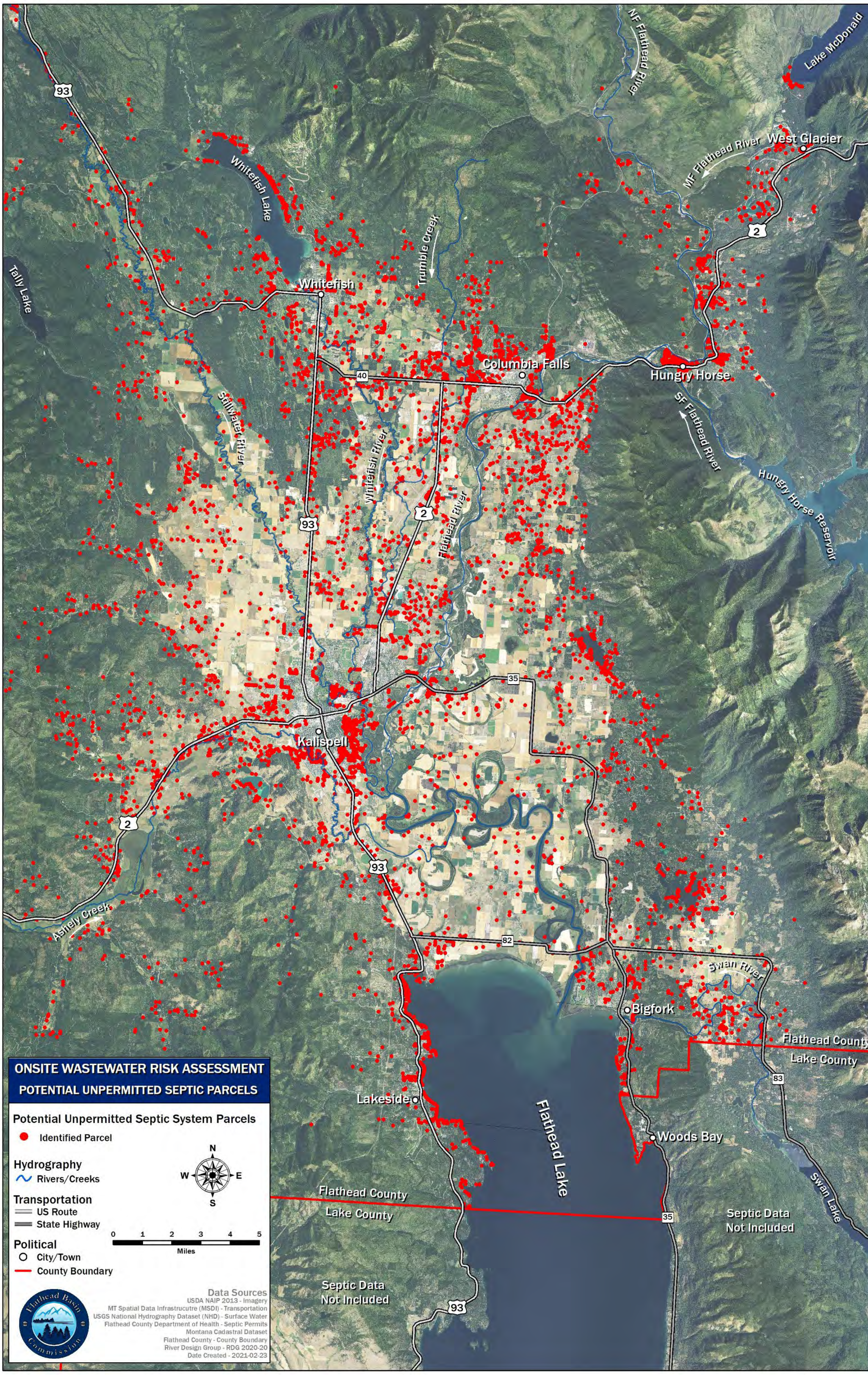


Figure A-14. Potential unpermitted septic system analysis map. Parcels in red indicate a high likelihood of septic system presence without an associated permit.

APPENDIX B

LAKE COUNTY MAPS

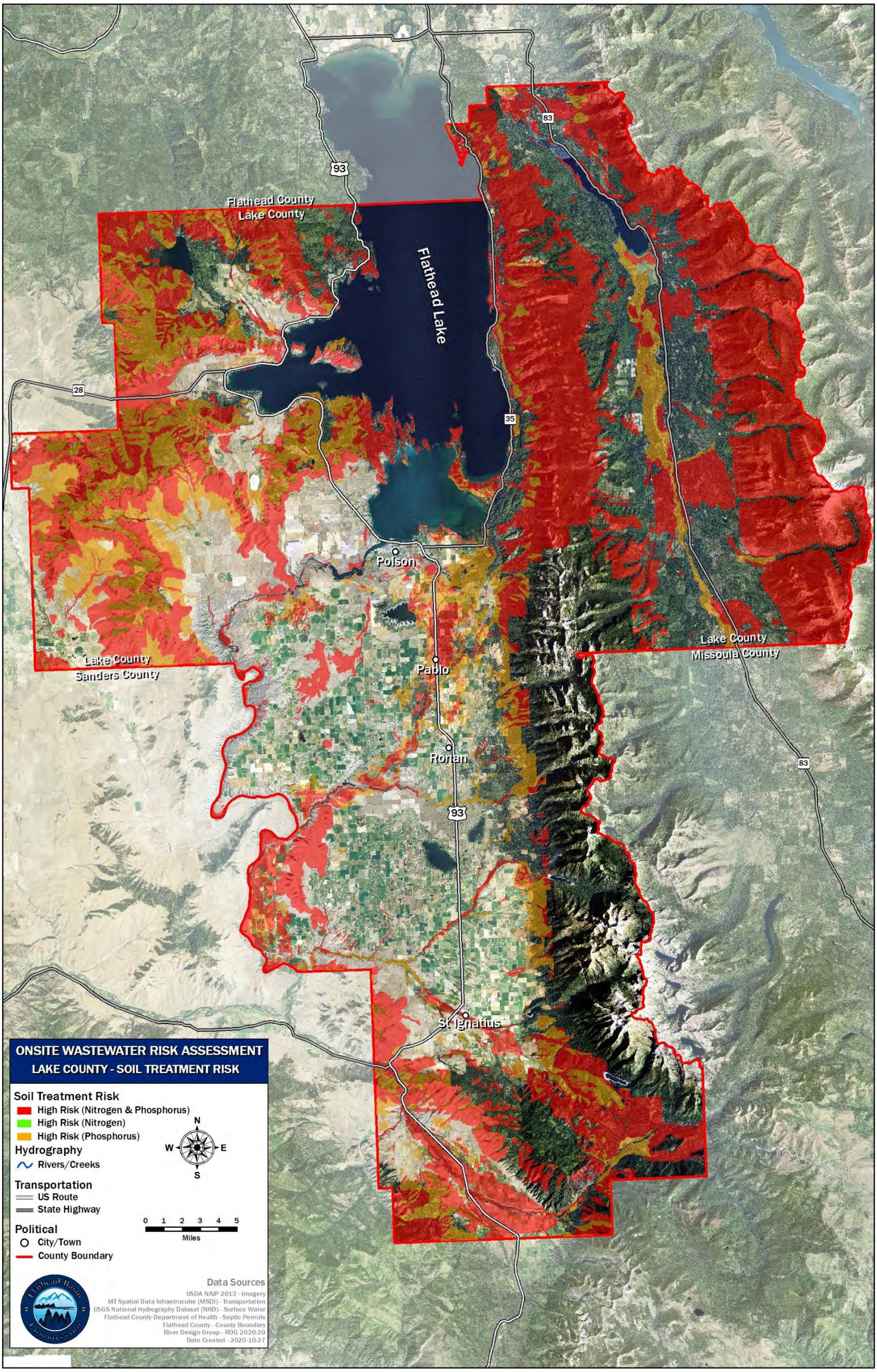


Figure B-15. Soil treatment risk map for phosphorous and nitrogen contimants from septic systems.

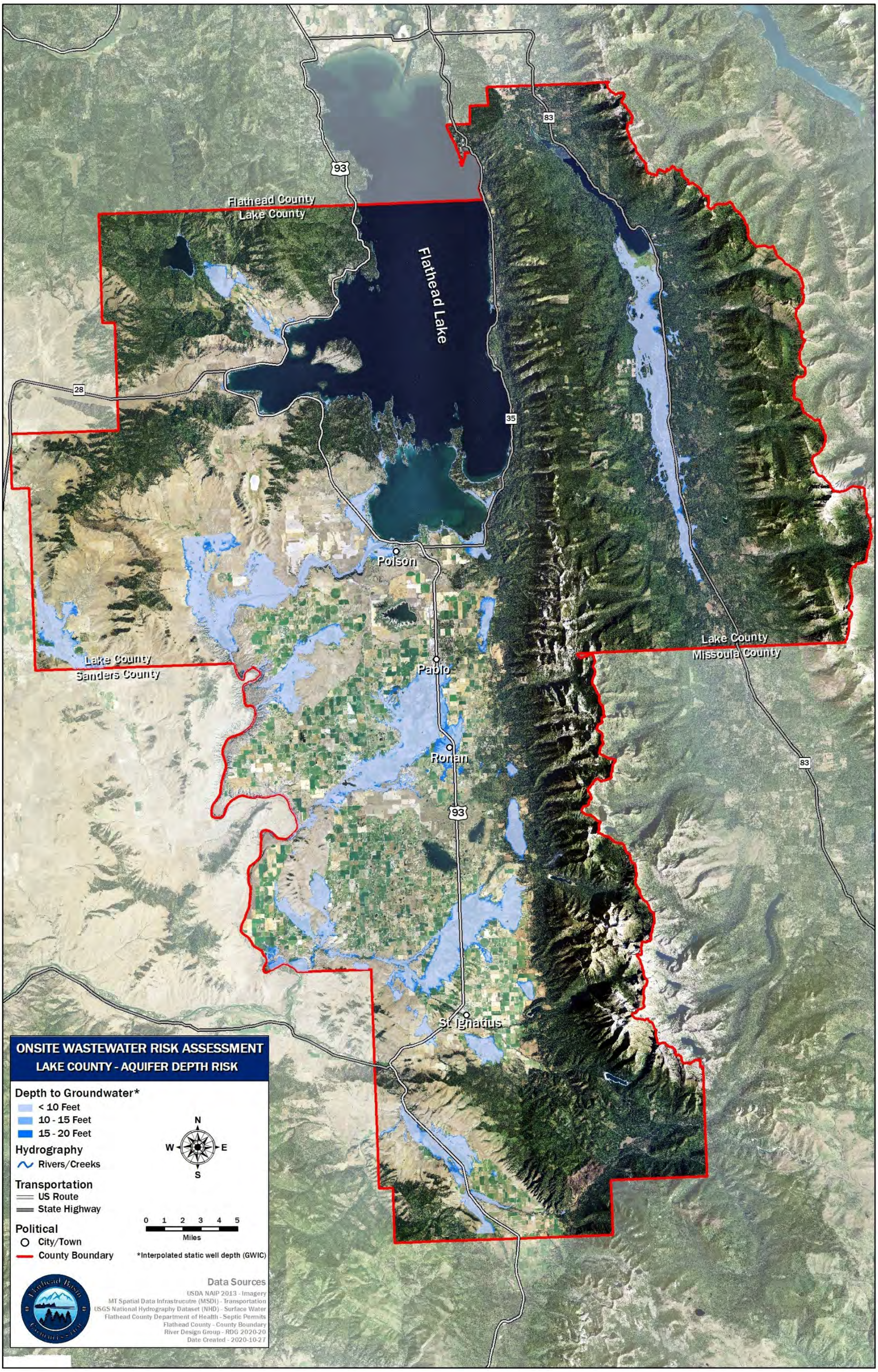


Figure B-16. Aquifer depth risk map with lighter blue areas having the shallowest groundwater and darker blue being deeper. Areas with no features indicate depths greater than 20 feet or lack of data.

Figure B-17. Surface water risk map based on the distance from a water body (river, lakes, and streams).

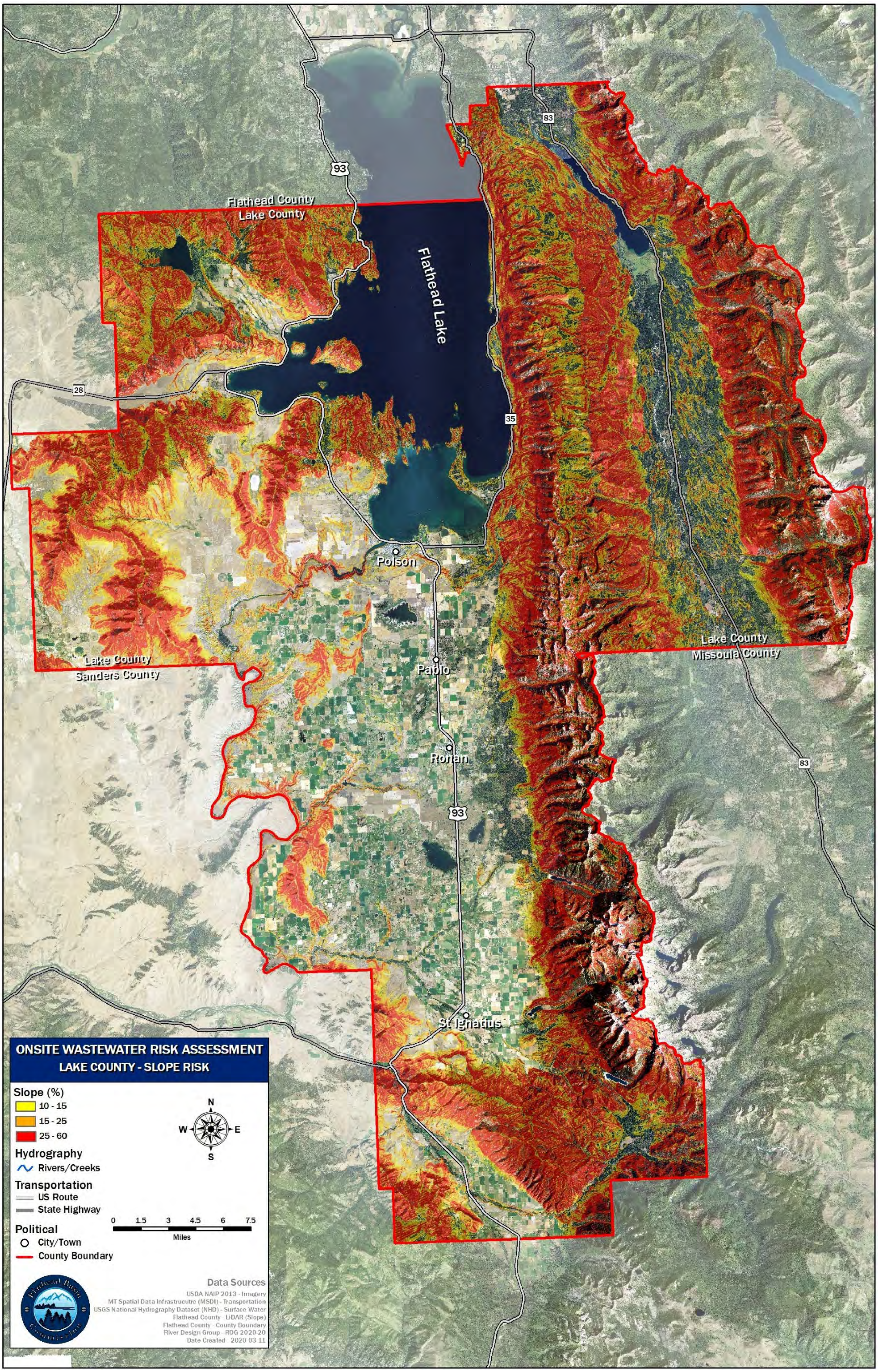


Figure B-18. Slope risk map for septic treatment. Areas in red would not be feasible for septic systems, while areas in yellow and orange could support septic at a higher risk.

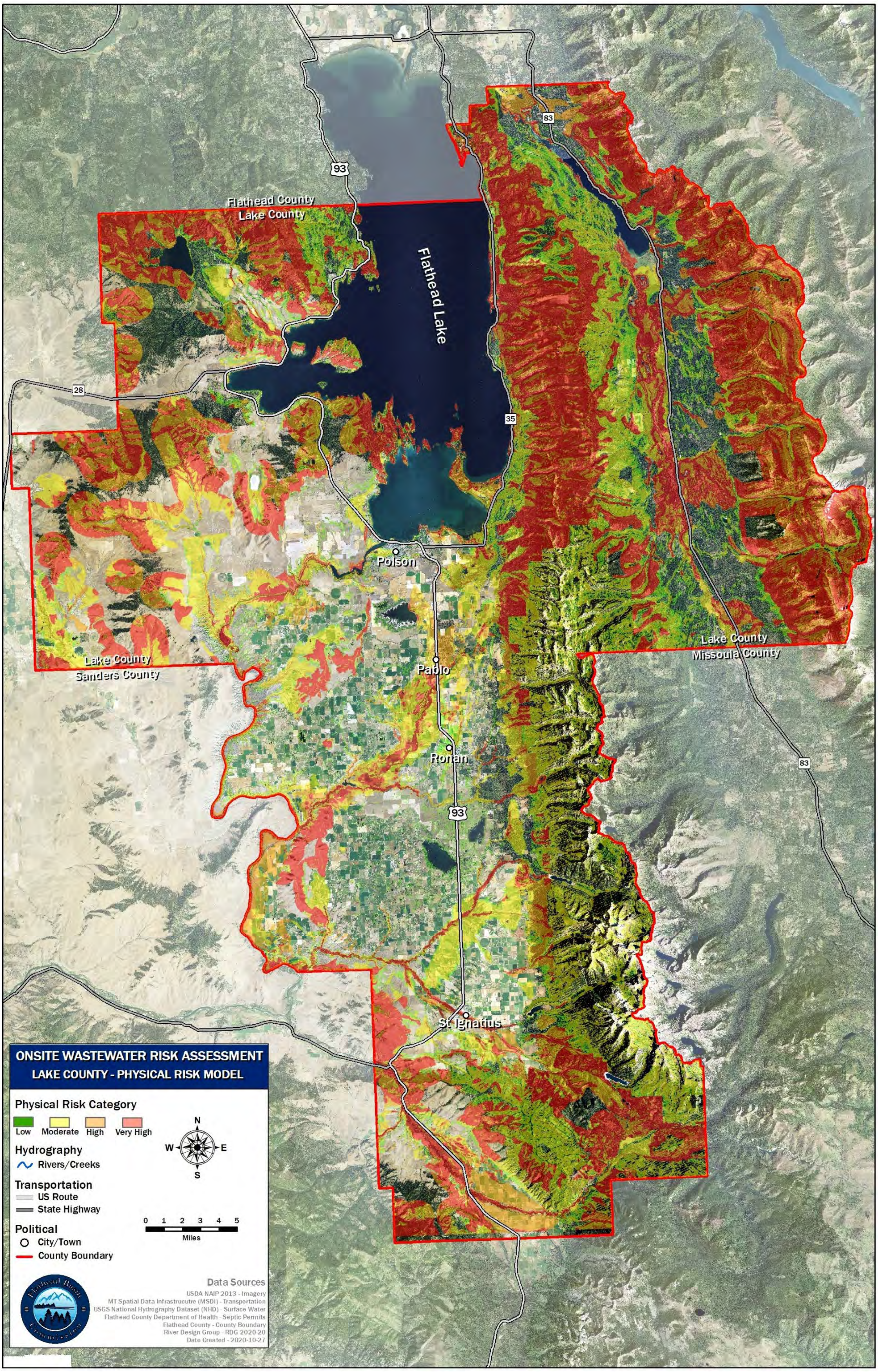


Figure B-19. Physical risk model map with areas at higher risk with warmer colors. Areas with very low risk are not shaded.

APPENDIX C

SOIL DATA

Table C-1. Upper Flathead Soil Survey: Nitrogen and Phosphorus Treatment Risk Rating

Soil Series	Nitrogen Risk	Phosphorus Risk
Aa Alluvial Land	High*	High
Ab Alluvial Land	High	Low
Alkali Land	Low	Low
Banks	High	High
Barzee	Low	High
Birch	High	High
Blanchard	High	High
Castner	High	High
Chamokane	High	High
Corvallis	Low	High*
Creston	Low	Low
Dahlake	Low	Low
Demers	Low	Low*
Depew	Low	Low
Flathead	Low	High
Foys Lake	Low	Low
Half Moon	Low	Low
Haskill	High	High
Idaho Creek	Low	Low
Kalispell	Low	Low
Kila	Low	Low
Kings Point	Low	Low
Kiwanis	High	High
Krause	High	High
McCaffery	High	High
McLangor	Low	High
McMannany	Low	Low
Mires	High	High
Mountain Lands	Low	Low
Muck & Peat	Low	High
Prospect	Low	Low
Radnor	Low	High
Repp	High*	High
Riverwash	High	High
Saline Land	Low	High
Selle	High*	High
Sharrot	High	High
Sommers	Low	Low

Stryker	Low	High
Swims	Low	Low
Tally	High	High
Tuffit	Low	Low
Waits	Low	Low
Walters	High	High
Whitebear	Low	High
Whitefish	Low	Low
Wimper	High*	Low
Winginaw	Low	Low
Yeoman	High	High

Table C-2. Flathead National Forest Soil Survey: Nitrogen and Phosphorus Treatment Risk Rating

Soil Series	Nitrogen Risk	Phosphorus Risk
Alluvial Lands (Well Drained)	High	High
Alluvial Lands (Poorly Drained)	Low	High
Organic Soils (Poorly Drained)	Low	Low
Silty Lacustrine (Well Drained)	Low	Low
Silty Lacustrine (Poorly Drained)	Low	Low
Silty Glacial Till - Residual Soils	Low	Low
Sandy Glacial Till - Residual Soils	High	High
Silty Glacial Till - Calcareous Substratum	Low	Low
Sandy Glacial Till	High	High

Table C-3. Flathead County and Part of Lincoln County Soil Survey: Nitrogen and Phosphorus Treatment Risk Rating

Soil Series	Nitrogen Risk	Phosphorus Risk
Ashely Lake	Low	Low
Bata	Low	Low
Battle Butte	Low	High
Big Draw	High	High
Big Lake	High	High
Bigarm	High*	High
Black Creek	High	High
Black Lake	Low	High
Bow Lake	Low	High
Combest	Low	High*
Courville	High	High
Crystaley	High	High
Eagle Wing	Low	Low
Finley Point	Low	High
Foys Lake	Low	Low
Glacier Creek	High	High
Haskill Pass	Low	High
Hogsby	High	High
Holloway	High	High
Kady Glutch	High	High
Lesier	High	Low
Lost Praire	Low	High
Lozeau	High	High
Lozeau Deep	Low	High*
Lynch Lake	High*	Low*
McCay	High	High
McCollum	High	High
McGregor	High	High
McLangor	Low	Low
Meadow Pass	Low	High
Meadowpeak	Low	High
Mine Singer	Low	High
Mitten	Low	High
Pashua	Low	High
Perma	High	High
Pleasant Valley	High	High

Quast	Low	Low
Repp	High	High
Rockhill	High	High
Rumble Creek	Low*	High*
Sol	Low	High
Stevie	High*	High
Tall Creek	Low	Low
Tamarack	High	High
Tevis	High	High
Tote Lake	High	High
Truman Creek	High	High
Waldbillig	High	High
Wildgen	Low*	High
Winfall	High	High
Winkler	High	High

APPENDIX D

UNPERMITTED SEPTIC SYSTEM SURVEY

Overview

In February of 2022, a postcard directing recipients to complete an online survey was mailed to nearly 8,000 properties across Flathead County. These properties were suspected to contain on-site wastewater treatment systems for which an existing permit was not found within the Flathead City-County Health Department's digital database. Respondents were asked to answer three questions:

- Is there a septic system at this address?
- What year was the system installed?
- If exact year of installation is unknown, select an estimate from the listed ranges of years. These ranges of years included before 1900, 1900-1950, 1950-1977, 1978-2000, and after 2000.

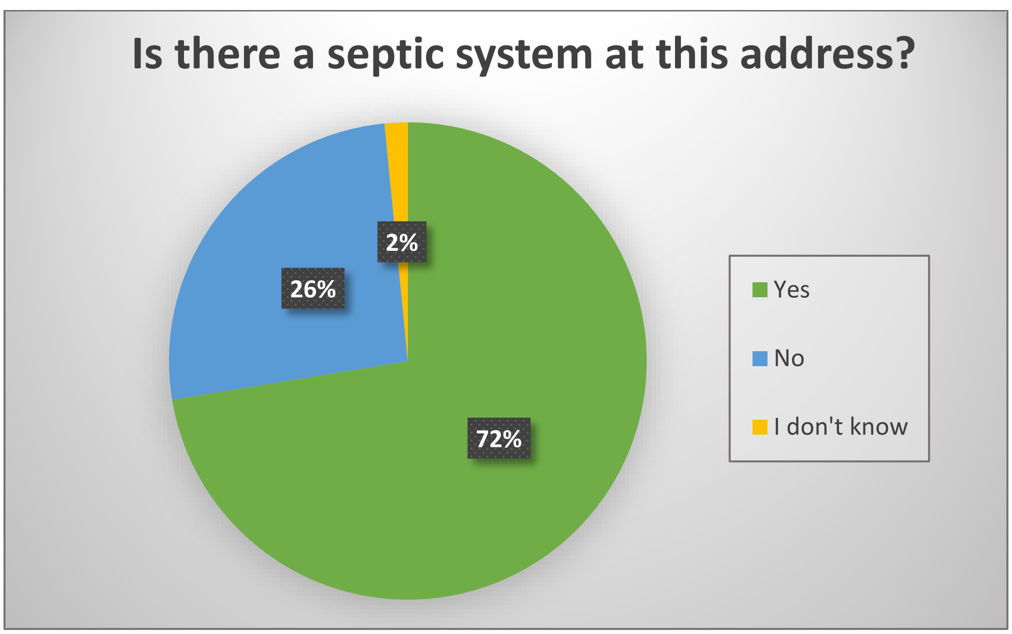
Respondents were also given the option to correct the listed address if the address printed on the postcard was incorrect. The purpose of this survey is to validate and further inform the Flathead Basin Commission's on-site wastewater risk model, which will be used to determine existing septic pollution risk and used as a tool to inform future development in the basin.

Results

Of the 7,747 property owners contacted, 192 unique responses were recorded, equating to an approximately 2.5% response rate. A few respondents submitted multiple entries, and in those cases, the response submitted last was assumed to be correct and used in the data analysis.

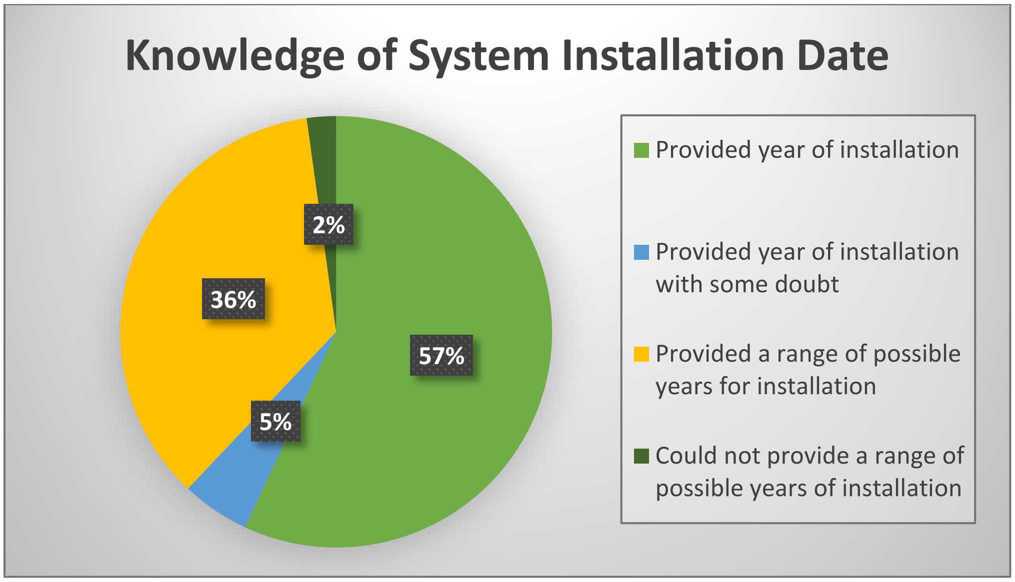
Presence of a Septic System

In response to the question of whether a septic system is present on the property, 139 responses confirmed the presence of a septic system, 50 denied the presence of a septic system, and 3 indicated that they did not know. There did not appear to be any correlation between the presence/absence of a septic system and geographic location in the basin.

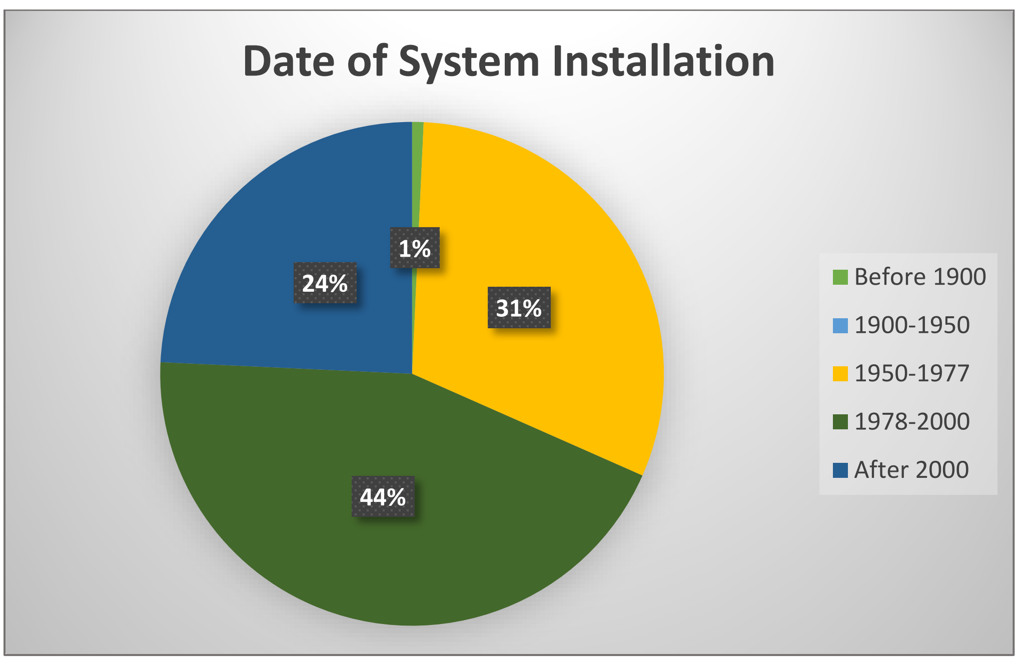


Date of System Installation

Of the 139 responses that indicated a septic system was present on the property, 79 were able to provide an exact year of installation, 7 provided a year of installation with some doubt, 50 provided an estimated range of installation years, and 3 were unable to provide a range of installation years.



Of the 136 responses that were able to provide a year or range of years of installation, 1 indicated the system was installed before 1900, 0 indicated the system was installed between 1900 and 1950, 42 indicated the system was installed between 1950 and 1977, 60 indicated the system was installed between 1978 and 2000, and 33 indicated the system was installed after 2000.



Summary

The majority (72%) of respondents confirmed the presence of a septic system on their property, and the vast majority of those with a septic system (98%) were able to provide an exact installation year or range of years, suggesting owners are knowledgeable about their systems. The vast majority (99%) of confirmed septic systems were reported to have been installed after 1950, and the largest percent of these (44%) have reported installation dates between 1978 and 2000. The remaining systems are evenly split between the 1950-1977 age category (31%) and the after 2000 age category (24%).

Additional Considerations

A more thorough investigation of the correlation between these results and geographic location in the basin may be valuable. For example, understanding how system age varies by location and uncovering possible trends could be informative to future work.

This report was last updated on March 28, 2022. It will continue to be updated if/when additional survey responses are submitted.

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