WHATCOM COUNTY CONTRACT INFORMATION SHEET

Whatcom County Contract No.

Originating Department:	Public Works
Division/Program: *(i.e. Dept. Division and Program)*	River & Flood/CFHMP(907525)
Contract or Grant Administrator:	Paula Harris, River & Flood Manager
Contractor's / Agency Name:	WA State Department of Natural Resources

Is this a New Contract? Yes ◉ No ○ If not, is this an Amendment or Renewal to an Existing Contract? Yes ○ No ◉
If Amendment or Renewal, (per WCC 3.08.100 (a)) Original Contract #: _____

Does contract require Council Approval? Yes ◉ No ○ If No, include WCC: _____
Already approved? Council Approved Date: _____ (Exclusions see: Whatcom County Codes 3.06.010, 3.08.090 and 3.08.100)

Is this a grant agreement?
Yes ○ No ◉ If yes, grantor agency contract number(s): _____ CFDA#: _____

Is this contract grant funded?
Yes ○ No ◉ If yes, Whatcom County grant contract number(s): _____

Is this contract the result of a RFP or Bid process?
Yes ○ No ◉ If yes, RFP and Bid number(s): _____ Contract Cost Center: 169104

Is this agreement excluded from E-Verify? No ○ Yes ◉ If no, include Attachment D Contractor Declaration form.

If YES, indicate exclusion(s) below:

- ☐ Professional services agreement for certified/licensed professional.
- ☐ Goods and services provided due to an emergency
- ☐ Contract work is for less than $100,000.
- ☐ Contract for Commercial off the shelf items (COTS).
- ☐ Contract work is for less than 120 days.
- ☐ Work related subcontract less than $25,000.
- ☒ Interlocal Agreement (between Governments).
- ☐ Public Works - Local Agency/Federally Funded FHWA.

Contract Amount:(sum of original contract amount and any prior amendments):
$ 129,760.00

This Amendment Amount:
$ n/a

Total Amended Amount:
$ 129,760.00

Council approval required for; all property leases, contracts or bid awards **exceeding $40,000**, and professional service contract amendments that have an increase greater than $10,000 or 10% of contract amount, whichever is greater, **except when:**

1. Exercising an option contained in a contract previously approved by the council.
2. Contract is for design, construction, r-o-w acquisition, prof. services, or other capital costs approved by council in a capital budget appropriation ordinance.
3. Bid or award is for supplies.
4. Equipment is included in Exhibit "B" of the Budget Ordinance.
5. Contract is for manufacturer's technical support and hardware maintenance of electronic systems and/or technical support and software maintenance from the developer of proprietary software currently used by Whatcom County.

Summary of Scope:

Interlocal agreement with Washington State Department of Natural Resources for collection, processing, and delivery of lidar topographic and bathymetric mapping of the Nooksack River.

Term of Contract: Not to Exceed	Expiration Date: project completion

Contract Routing:

1. Prepared by:	C. Schoenfelder	Date: 11/4/2021
2. Attorney signoff:	Christopher Quinn	Date: 11/16/2021
3. AS Finance reviewed:	M Caldwell	Date: 11/16/21
4. IT reviewed (if IT related):		Date:
5. Contractor signed:		Date:
6. Submitted to Exec.:		Date:
7. Council approved (if necessary):		Date:
8. Executive signed:		Date:
9. Original to Council:		Date:

Last edited 07/06/20

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

Cost Share Agreement

DNR Contract No. 93-102925

Whatcom County Flood Control Zone District Contract No. Enter agreement number[HB(1]

In accordance with Chapter 39.34 RCW, Washington State Department of Natural Resources (DNR) and Whatcom County Flood Control Zone District (FCZD) agree to a cost share agreement for lidar collection and geospatial mapping.

Pursuant to Cost Share Agreement number 93-102925 between DNR and FCZD:

1. The FCZD wishes to acquire bathymetric lidar data and derivatives for the Nooksack River area.

2. Per the agreement, DNR will act as the agent for this purchase.

3. This agreement covers the collection, processing and delivery of lidar data and derivative products as outlined in Nooksack River and Optional Areas proposal provided by Quantum Spatial, for the Nooksack and North Fork Add-on options, attached as Exhibit A.

4. The total cost is not to exceed One Hundred Twenty-Nine Thousand Seven Hundred Sixty Dollars ($129,760).

5. If a suitable collection window for the lidar data does not occur in the winter of 2022, this cost share agreement will become null and void and a new cost share agreement will be developed for the next suitable collection window.

6. DNR shall submit one invoice for the FCZD's share of the services. Payment for the approved good/services will be made by check, warrant or account transfer within 30 days of receipt of the invoice. Upon expiration of the Agreement, invoice shall be paid, if received within 30 days after the expiration date. However, invoices for all work done within a fiscal year must be submitted within 30 days after the end of the fiscal year.

This agreement may be revoked at any time in writing by either party, provided, however, the FCZD agrees to pay for any services rendered under this agreement prior to termination.

Accepted for: Flood Control Zone District	Accepted for: Washington State Department of Natural Resources
[CS2][HB(3] SEE ATTACHED SIGNATURE PAGE	
	Casey Hanell Director, Washington Geological Survey 360-902-1439
Date:	Date:

Exhibit A

November 10, 2021

Abby Gleason

LiDAR Manager

Washington Geological Survey

Department of Natural Resources

(360) 902-1560

abigail.gleason@dnr.wa.gov

RE: Nooksack River and Optional Areas, Whatcom County, WA

NV5 Geospatial appreciates the opportunity to present **Washington Department of Natural Resources (WA DNR)** with a quote and brief statement of work for geospatial mapping services along the Nooksack River, Whatcom County, WA. A brief synopsis of our services, specifications and associated costs for these areas of interest are provided below. The project site will be sufficiently buffered to ensure complete coverage within the project limits.

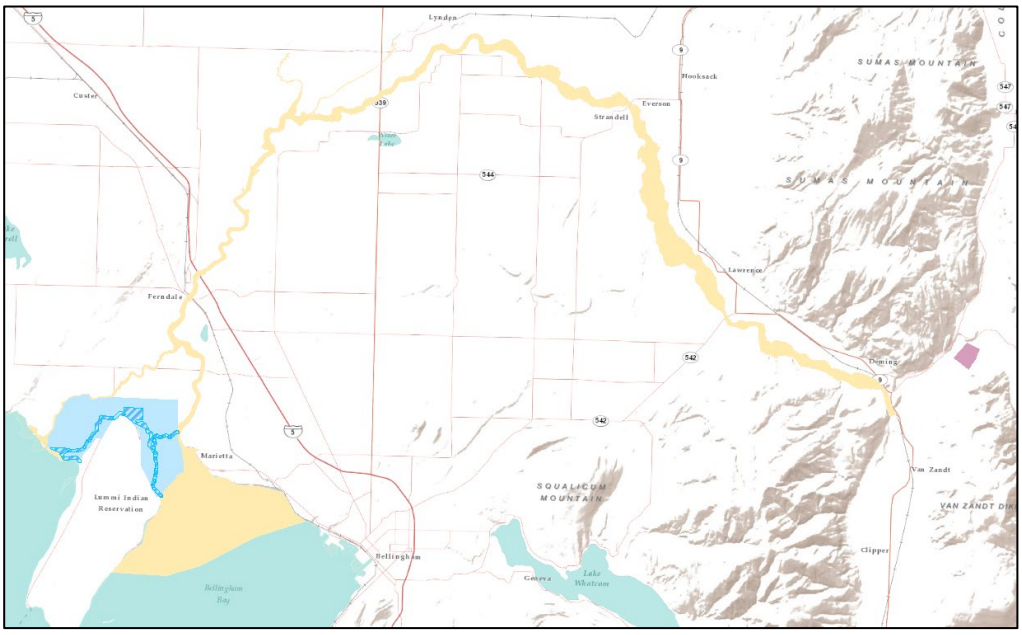


Figure 1: Main area of interest is all area in orange (8989 acres). Add on areas are "North Fork" 141 acres in rose; "Smugglers Large" 2657 acres in blue; and "Smugglers Small" 385 acres in blue hashed.

Topo-bathymetric Lidar Acquisition & Processing

Topo-Bathy Lidar Specifications Summary	
Target Pulse Rate	245 kHz
Laser Wave Length	532nm
Laser Pulse Diameter	28-53 cm
Intensity	16-bit
Field of View	40°, 20° forward fixed angle

Topo-bathymetric Lidar data will be acquired using one of NV5 Geospatial's hydrographic airborne laser systems. The systems contain a green wavelength (λ=532 nm) laser capable of penetrating water, with high repetition pulse rate, high scanning speed, small laser footprint, and wide field of view together facilitate high resolution coverage of topographic and bathymetric surfaces. Additionally, the Riegl's short laser pulse length is ideal and critical for shallow-water systems as it allows for effective discrimination between water and bathymetric surfaces which can be challenging when mapping near-shore, shallow, and dynamic aquatic environments.

The green laser will collect both topographic and bathymetric Lidar data to produce a high resolution topo-bathymetric data set **(≥15 pulses/m^2)** with a fixed scan angle of ±20° (off nadir). The Riegl system has demonstrated hydrographic depth ranging capability of at least 1.5 Secchi depth on bright reflective surfaces. The laser will not penetrate dense aquatic vegetation or turbid waters. Water clarity affects the depth penetration capability of the bathymetric laser with returning laser energy diminishing by scattering throughout the water column. Additionally, the bottom surface must be reflective enough to return remaining laser energy back to the sensor at a detectable level. Actual depth performance will depend on bottom reflectivity and water clarity at time of acquisition. Data will be collected during the best possible conditions for success which include no fog/rain and any other conditions affecting water clarity.

Lidar processing tasks involve echo extraction; calculations of laser point position; flight line calibration; water surface extraction; refraction correction; point classification; and accuracy assessments. Derived topo-bathymetric DEMs will be developed once the seamless topographic/bathymetric Lidar point cloud is finalized for positional and classification accuracy. NV5G will evaluate clarity and reflectivity as they impact the dataset. Depths ranging beyond the sensor's detection capability will produce voids in the data set. Voids will be identified in the dataset as

well as evaluated in reporting. Our team will assess the accuracy of the topo-bathymetric Lidar system using bare earth and, if available, shallow water check points collected during the survey. Past experience has shown bathymetric surface accuracies of ≤ 10.0 cm RMSE.

Survey Control

Depending on acquisition logistics (configuration of sites, access, schedule, and weather), NV5G will use one or more appropriate methods to enable geo-spatial correction of aircraft positional coordinate data. These include conventional base supported ('BS') survey control, TerraPos® Precise Point Positioning ('PPP'), or Trimble® CenterPoint™ Post-Processed Real-Time Extended ('PP-RTX'). To verify Lidar point calibration and enable accuracy assessment, our field crew will collect ground check points (GCPs) using GPS-based real-time kinematic (RTK) survey techniques. For an RTK survey, the ground crew uses a roving unit to receive radio-relayed corrected positional coordinates for all ground points from a GPS base unit set up over a survey control monument. The roving unit records precise location measurements with an error (σ) of ≤1.5 cm relative to the base control. Our team will distribute a suitable number of hard, bare earth ground check points (GCPs) on level slope throughout project areas, as feasible given road access and GPS conditions. The techniques for establishing all ground check points will be outlined in the Report of Survey, including the identity, locations, and position residuals of all GCPs used to evaluate survey accuracy. All survey control and accuracy will be validated and certified by NV5G registered land surveyor

for Washington. **Secci depth measurements will be taken at suitable locations as close to acquisition time as possible and at locations safe for the field surveyor to access.**

Deliverables

Coordinate System

Washington State Plane North, NAD83 (HARN), NAVD88 (Geoid 12b), US Survey Feet unless otherwise specified.

NIR Lidar with Topobathy

Ground Control Points: Location and orthometric height of all GCPs. Additional attributes that may be included are ellipsoidal height and a description of the ground cover type where the measurement was taken, *shapefile format*
Aircraft Trajectories: Smoothed Best Estimate of Trajectory (SBET) files with aircraft position (easting, northing, and elevation), attitude (heading, pitch, roll, yaw) and GPS time recorded at regular intervals of 1 second or less. May include additional attributes (PDOP and estimated positional and velocity errors).
Lidar Flightlines: attributed with project name, and date of acquisition of each flightline, *shapefile or ASCII text format*

All Return Point Cloud:

- LAS V1.4 format
- Including all valid returns, with all fields populated
- Attributes must include, at a minimum, class number, class name, line number, GPS seconds per week, echo label (only, last, etc.), easting/northing/elevation (reported to nearest 0.01 meter), intensity, scan angle, echo number, and system gain or scanner
- Following USGS LBS 2020 revision A (or most current version thereof) for classification scheme (No points should retain a classification of 0)
- Red, Green, Blue Infrared (RGBI) values must be attributed when applicable
- No duplicate entries
- Time reported to the nearest microsecond or better
- Classification of ground returns must be as complete as is feasible and without avoidable return misclassification
- ***Topobathy*** Includes additional bathymetric ground, water column, water surface classifications

Bare Earth Surface Model:

- *Erdas .img, GeoTiff, Esri Grid formats*
- No tiling artifacts and no gaps at tile boundaries, or artifacts such as pits, birds, striping or aliasing.
- Areas outside survey boundary shall be coded as NoData with the value '-999999'.
- Internal voids (e.g., open water areas) shall be coded with the value '-999999'.
- 32 bit pixel depth floating point grid at a 1.5 ft (0.5 meter) cell resolution snapped to the corner
- ***Topobathy*** Includes Topo-bathymetric Bare Earth Digital Elevation Model (DEM), 1 m (3-ft) resolution, *ERDAS IMG format*
- ***Topobathy*** Bathymetric Coverage Polygon, *shapefile format*

First Return Surface Model:

- Raster generated from the highest collected return for each cell
- Same specifications as for Bare Earth Surface Model
- Cells without first returns will be coded as NoData.

Intensity Images:

- *GeoTiff format, grayscale*
- Normalized if the sensor or combination of sensors used on the project allow
- Grids must be georeferenced 8-bit pixel depth (unless otherwise specified in the purchase order)
- 1.5ft (0.5 meter) cell resolution

First Return Point Density Raster:

- *Erdas .img, GeoTiff, Esri Grid formats*
- Raster illustrating number of first return per resolution cell over the project area
- 8 bit pixel depth grid
- 98.5 ft cell resolution (30m) unless otherwise specified in purchase order, snapped to the corner
- mosaicked to cover entire project extent

Swath Density Raster:

- A raster showing the number of swaths collected per resolution cell
- 8 bit pixel depth grid at a 1640.5 ft cell resolution (500m) unless otherwise specified in purchase order, snapped to the corner
- mosaicked to cover the entire project extent

Survey Report

- *Delivered in .pdf or .docx formats*
- **Project Overview**, including:
    - project name, location map, date collection was ordered, acquisition window, delivery date(s), project AOI, project total area flown, specified units, coordinate system and datum, list of options requested
- **Lidar Acquisition Information**, including:
    - map of flightlines indicating dates of collection
    - acquisition parameters (table) including aircraft, sensor, acquisition settings, flight elevation
- **Report of the ground survey**, including
    - reference map and table listing monuments used and location
    - detailed description of GPS procedures used in establishing the reference network and control points for the project
    - location and height (orthometric) shall be included in as a digital appendix to the report, *shapefile format*
- **Washington State Licensed Surveyor Certification**
- **Calibration Report** for the system(s) used in the data acquisition
- **Projection, datum, epoch of adjustment, and Geoid** used for the survey.
- **Accuracy Assessment**:
    - Relative Accuracy, Absolute Accuracy (summary statistics and histogram).
    - Reported to meet the guidelines of the National Standard for Spatial Data Accuracy (FGDC 1998) and ASPRS 2014).
- **Assessment of Pulse Density**, including maps showing design pulse density and ground return densities by quarter-quadrangle and histograms of both density parameters.
- **Summary Table of Deliverables**, listing file formats and total number and data volume of each deliverable, paths on the delivered hard drive, a standardized description of the data tiling scheme, and a checklist of all deliverables.
- **Metadata:** GIS-compatible data and files shall be explained with XML format metadata that follows the Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Data. Metadata may be a single file that describes an entire survey or multiple files each of which describes a constituent part (e.g., area A, area B, area C) of the survey.

Tiling Scheme

All geospatial products will be delivered in a 4500 x 4500 foot tiling scheme unless otherwise specified. Esri grids, shapefiles will have complete and correct associated projection files. Tiled products will be edge matched, without gaps or overlap.

Delivery Method

All data will be provided on marked (following consistent nomenclature and versioning info) portable hard drives with appropriate documentation and metadata records. All filenames will follow mutually-agreed upon nomenclature. Each drive will have an identification sticker, identifying the project, delivery, and ship date, as well as serialize the drive ID. Each drive will be delivered with a hard and soft copy of a transmittal letter (emailed to WA DNR the day of shipment). Version control will feature records of each version including (as a minimum) version, date, size, impacted bins, and fixes.

Schedule & Timeline

NV5G will work with DNR to coordinate data collection to coincide with optimal weather conditions and as best meets the needs of the project. We anticipate collection to occur in January/February 2022 during low flow, leaf off and low tide conditions. **See the following attachment "Proposed Constraints" for specific condition parameters for tides and turbidity.** All products will be delivered 60 business days from date of successful acquisition.

Preliminary products for the 141 acre site named "North Fork Add-on" will be delivered three weeks after successful collection. NV5G will coordinate with DNR and stakeholders to utilize established survey monuments where possible and gain access to property. Should NV5G not achieve collection during the optimal window this season, a time-only extension to the contract may be made to allow for a winter 2022/2023 collection.

Cost Estimate

Costs below are for the study areas portrayed in Figure 1 above, assuming timeline and the deliverables listed above. Changes in the size and/or shape of the area of interest will result in modifications to the cost structure. Costs include mobilization, acquisition, survey, processing to products and reporting. Add-on costs assume Nooksack AOI (8989 ac) is contracted. A contingency cost is itemized here in the event that a second mobilization is required. If a second mobilization is not required, then no charge will be made.

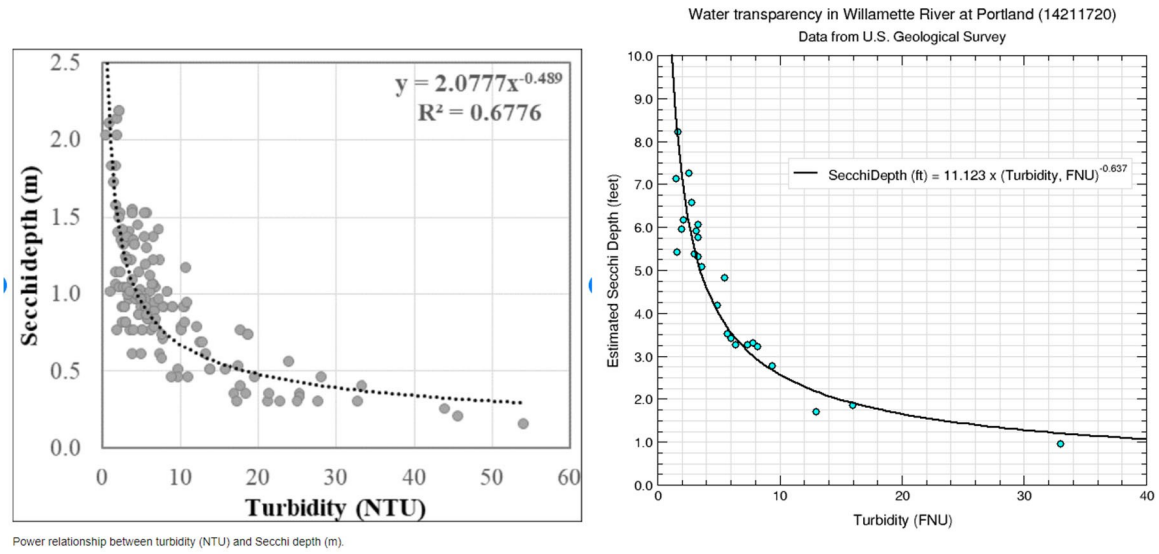
Areas of Interest for Nooksack Topobathy	***Cost***
All Nooksack 8,989 acres	$117,960
North Fork Add-on 141 acres	$1,990
Smugglers Large Add-on 2,657 acres	$2,660
Contingency Mobilization	$7150

We greatly appreciate the opportunity to be considered for this project. Should you have further questions or comments please feel free to contact **Melissa Christie at melissa.christie@nv5.com or 925-586-8301.**

Turbidity Criteria

The Nooksack River is glacially fed and has a high turbidity level much of the time. In order to acquire the highest quality bathymetric data constraints are needed to guide the vendor on when data acquisition flights are allowed. These constraints must allow a realistic opportunity to acquire the data during the winter of 2021/2022.

Bathymetric Lidar penetration estimates: The LiDAR vendor states that under typical conditions the LiDAR should be able to acquire data to 1.5X Secchi depth. On the Nooksack River real-time turbidity data is available, so a correlation with Secchi depth allows us to estimate equivalent turbidity levels. We found two correlations using a quick web search, the results were similar:



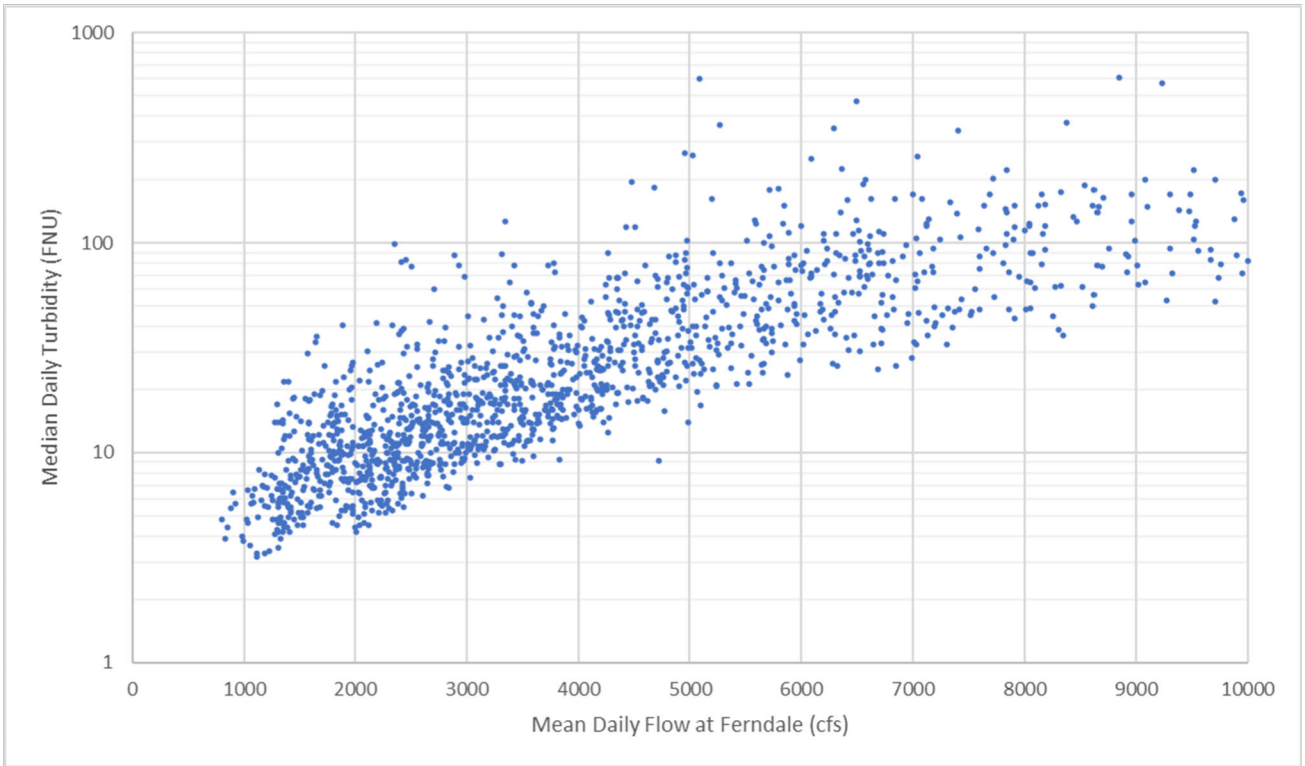
Power relationship between turbidity (NTU) and Secchi depth (m).

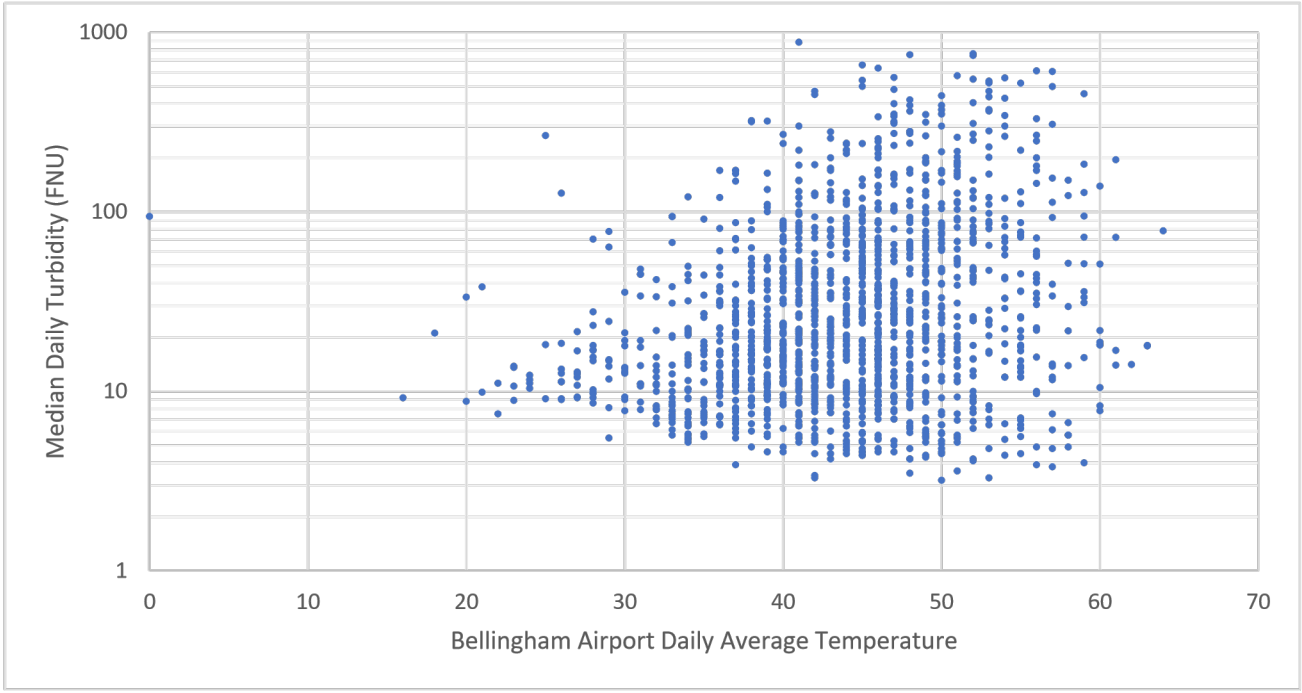
https://www.researchgate.net/figure/Power-relationship-between-turbidity-NTU-and-Secchi-depth-m_fig2_338113358

https://or.water.usgs.gov/will_morrison/secchi_depth_model.html

From these curves it is apparent that turbidities less than 5 NTUs would be desirable, and less than 10 NTUs required to get any amount of significant bathymetric coverage of the river bed, especially considering the data acquisition will occur during deeper winter flow conditions.

The next question is whether or not these targets are achievable on the Nooksack River. We downloaded all available flow and turbidity data for the Ferndale gage (2011 – present, with significant missing data periods), and filtered it for winter months (Oct-Mar). We also downloaded Bellingham Airport weather data. Our hypothesis was that the clearest water in the winter months occurs during long cold spells when most of the basin is not generating runoff and flows are low. The following figures present some correlations with turbidity, note the log scale for turbidity.





- Key Findings
  - Turbidities less than 5 NTUs rarely occur on the Nooksack River
  - Turbidities less than 10 NTU never occur when flows exceed 4000 cfs
  - Somewhat surprisingly, the lowest turbidities occur during warmer temperatures, not during frozen conditions.

Based on the data, we feel that 10 NTU is a reasonable compromise upper turbidity threshold for LiDAR data acquisition. We checked this was reasonable by calculating the number of days/month turbidities were less than 10 NTU for the period of record. Note water year 2018 had no data, and there are

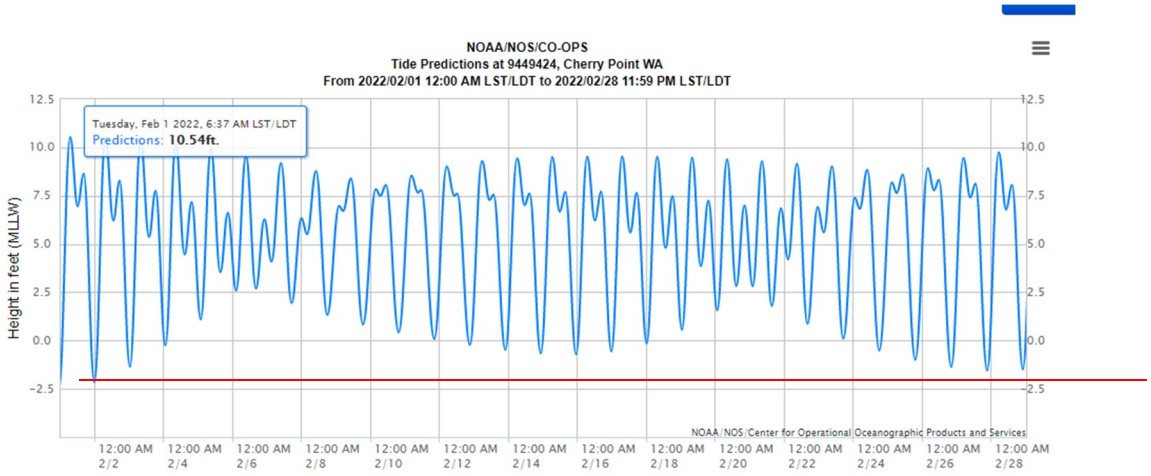
periods of missing data throughout the record, so the numbers may underestimate the total number of days that met the criteria.

Mon	2011	2012	2013	2014	2015	2016	2017	2019	2020	2021	Totals
Oct	1	3	14	0	19	8	0	9	1	0	55
Nov	15	0	8	3	0	0	0	20	2	0	48
Dec	19	3	8	0	1	1	0	12	5		49
Jan		3	13	2	1	11	14	0	0	6	50
Feb		3	19	5	7	0	4	4	1	3	46
Mar		6	6	0	6	0	0	17	16	27	78
Total	**35**	**18**	**68**	**10**	**34**	**20**	**18**	**62**	**25**	**36**	**326**

The table shows that every winter month has had low turbidity days. March had had the highest number of clear water days, especially in the last three years.

Tide Criteria:

We suggest requiring that data acquisition in tidal areas be limited to times when the NOAA Cherry Point tide gage is at or below MLLW. This will almost certainly require nighttime acquisition for any period before March. Sequences of low tides below MLLW occur every other week, and this criterion should allow around half of the days in each month to be considered.



https://tidesandcurrents.noaa.gov/stationhome.html?id=9449424

WHATCOM COUNTY FLOOD CONTROL ZONE DISTRICT:
Recommended for Approval:

_____

Jon Hutchings, Public Works Director Date

Approved as to form only:

_____

Christopher Quinn, Date
Senior Deputy Prosecuting Attorney – Civil Division

Approved:
Accepted for Whatcom County Flood Control Zone District

By: _____

Satpal Singh Sidhu, Whatcom County Executive, Date
acting for the Whatcom County
Flood Control Zone District Board of Supervisors