Enhancing Waterfowl Nesting Habitat in the Dinosaur Watershed

Fish and Wildlife Compensation Program

Blackbird Environmental Ltd.

Final Report - R0

February 1, 2021

Blackbird File No.: 20010
FWCP Project No.: PEA-F21-W-3223

Prepared with financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations, and Public Stakeholders.

Executive Summary

During the fall of 2020, Blackbird Environmental Ltd. (Blackbird) installed 19 artificial nesting structures aimed to enhance waterfowl habitat within the Fish and Wildlife Compensation Program's (FWCP's) Dinosaur sub-region of the Williston reservoir. These structures were designed to target waterfowl species within the region including bufflehead (*Bucephala albeola*), common and Barrow's goldeneye (*Bucephala clangula, Bucephala islandica*), common merganser (*Mergus merganser*), Canada goose (*Branta canadensis*), common loon (*Gavia immer*), and mallard (*Anas platyrhynchos*).

The subject project was completed under guidance of the FWCP's 2014 Peace Region Action Plans. Specifically, this project's primary objective has been completed under the Peace Basin Riparian and Wetlands Action Plan Objective 2 and Priority Action 2b-2:

- Objective 2: Conserve or enhance the ecological integrity of riparian and wetland ecosystems,
- Priority Action 2b-2: Install artificial nesting or roost structures for wildlife species (FWCP 2014a).

This project had a secondary objective, which aligns with the 2014 Peace Basin Plan's goal of funding Stewardship and Education programming by involving local communities as much as possible to increase awareness of local waterfowl and waterfowl habitat needs (FWCP 2014b). The secondary objective of this project was to:

- spark community interest in the importance of waterfowl and suitable waterfowl habitat by collaborating with the local community during project execution.

Blackbird successfully installed 17 newly constructed wooden nest boxes at four unique sites throughout the FWCP's Dinosaur sub-region. Nest box construction and deployment included community involvement, with support provided by the Hudson's Hope Elementary and Secondary School and Saulteau First Nations. These boxes have been mounted in trees around Dinosaur Reservoir and wetland complexes along the Johnson Creek Forest Service Road.

In addition, two floating islands of a novel design were installed by Blackbird within two unique wetland complexes along the Johnson Creek Forest Service Road. These islands were designed to provide loafing and/or nesting habitat for waterfowl while being portable and suitably buoyant for wildlife use, with enhanced longevity and minimal risks of detrimental environmental impacts.

This report provides a summary of the waterfowl habitat enhancement structures installed, community engagement activities which were completed, as well as specific recommendations for the design and implementation of future maintenance and follow-up programs.

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Revision No.	Date	Reason/Type of Revision
Rev. 0	February 1, 2021	Final report issued

1 Introduction

The Fish and Wildlife Compensation Program (FWCP), a partnership between the BC Hydro and Power Authority (BC Hydro), the Province of BC, Fisheries and Oceans Canada, First Nations, and Public Stakeholders provides annual funding to projects aimed at conserving and enhancing fish and wildlife in watersheds impacted by exiting BC Hydro dams.

Under the FWCP's Peace Region Action Plans, waterfowl habitat in the FWCP's Parsnip Arm sub-region watershed has successfully been augmented for 30 years. An important component of these enhancement activities during this time has been the installation, monitoring, and maintenance of artificial nesting and roosting structures.

To expand on the successful waterfowl habitat augmentation program implemented within the FWCP Parsnip Arm program, Blackbird Environmental Ltd. (Blackbird) adapted the model within the FWCP's Dinosaur sub-region watershed, utilizing existing research and newly available predictive wetland riparian habitat modelling to identify suitable enhancement areas and subsequently construct and install nesting structures.

2 Goals and Objectives and Linkage of FWCP Action Plan and Specific Action(s)

The subject project has been completed under the FWCP's 2014 Peace Region Action Plans. Specifically, this project's primary objective has been completed under the Peace Basin Riparian and Wetlands Action Plan Objective 2 and Priority Action 2b-2:

- Objective 2: Conserve or enhance the ecological integrity of riparian and wetland ecosystems,
- Priority Action 2b-2: Install artificial nesting or roost structures for wildlife species (FWCP 2014a).

Suitable nesting and roosting habitat for waterfowl species is limited near the Dinosaur reservoir due to the reservoir's steep shoreline and water level fluctuations associated with dam operations. This project was designed to enhance nesting opportunities and the reproductive productivity of waterfowl in the watershed by providing artificial nesting structures in suitable riparian and wetland areas in the sub-region. Through this project, Blackbird aimed to accomplish the following habitat enhancement goals and objectives:

- enhance the number and availability of suitable nesting sites for cavity and island-nesting waterfowl and wildlife species (e.g., bufflehead, merganser spp., goldeneye spp., etc.) within the FWCP's Dinosaur sub-region, and ultimately
- increase waterfowl presence and population sizes.

In addition, this project's secondary objective aligns with the 2014 Peace Basin Plan's goal of funding Stewardship and Education programming by involving the local communities as much as possible to increase awareness of local waterfowl and waterfowl habitat needs (FWCP 2014b). The secondary objective of this project was to:

- spark community interest in the importance of waterfowl and suitable waterfowl habitat by collaborating with the local community during project execution.

Specifically, Blackbird collaborated with available First Nations monitors during project execution, allowing for participation and feedback opportunities, as well as with Hudson's Hope Elementary and Secondary School (HHESS), delivering targeted outreach activities to the involved students and their families.

3 Study Area

This project took place within the Dinosaur subregion of the FWCP's Peace Region. When evaluating the location of suitable waterbodies for enhancement, we assessed the entire Dinosaur watershed, considering accessibility, safety, and waterfowl habitat suitability. A total of four sites, located between 8 and 40 km west and southwest of Hudson's Hope and consisting of waterbodies and wetland complexes, were selected for floating island and nest box placement (see Appendix B, Figure 1).

4 Project Phases & Methods

The Dinosaur Sub-region waterfowl nesting habitat enhancement project included three primary phases, summarized below, including a desktop review, community engagement, education and outreach, as well as a field program. As a final phase, the results of the program have been compiled into the subject report.

4.1 Desktop Review

A preliminary desktop review of the watershed was completed to review available waterfowl habitat and locations potentially in need of enhancement. We reviewed current publicly available aerial imagery, topography, hydrology, and geospatial information for the subject area to aid in identifying potential focal points for field scouting. In addition, we reviewed provincial and scientific databases for tree and island-nesting waterfowl habitat requirements and enhancement design considerations.

Data layers accessed for the purpose of this assessment included georeferenced data related to fish and wildlife, hydrology and wetlands, cultural features (e.g., roadways & industrial activities), forestry and vegetation, as well as terrain (Table 1).

Table 1: Information Sources for Dinosaur Sub-region Waterfowl Habitat Enhancement Site Selection

Information Reviewed	Data Source
Waterbody names, locations & connectivity	· Fish Inventory Data Queries · BC Watershed Atlas · BC Freshwater Atlas
Dinosaur Sub-region Wetland Distribution	· Williston Wetland Explorer Tool
Watershed Hydrology	· NorthEast Water Tool
GIS Data	· DataBC Data Distribution Service
Waterfowl Data	· Scientific Journals · eFaunaBC · Atlas of the Breeding Birds of British Columbia · The Cornell Lab of Ornithology · eBird Canada
Nesting Structure Design Development	· Ducks Unlimited · Bird Studies Canada · The Royal Society for the Protection of Birds (RSPB) · Historic Peace/Williston Fish & Wildlife Compensation Program enhancement projects · Minnesota Department of Natural Resources Nongame Wildlife Program

Preference was given to locations and areas requiring enhancement which would be suitably accessible to the public for access and viewing (i.e., the locations are accessible via a maintained road or boat). This also ensured the selection of enhancement sites which were suitably accessible to ease future maintenance activities and reduce both current project and future maintenance costs.

4.1.1 Nest Box Design & Site Selection

Nest box locations were selected based on published habitat requirements of cavity-nesting waterfowl and site parameters ensuring box longevity in accordance with Ducks Unlimited Canada (DUC) recommendations, while also considering public viewing opportunities (DUC 2008, DUC date unknown, Holopainen et al. 2015).

Live, healthy deciduous trees (e.g., trembling aspen, balsam poplar, or white birch) within 50 m of the water's edge and with minimal undergrowth were preferentially selected for box placement as these sites offer minimal flight path obstructions and minimal risk for fledging ducklings. Boxes were placed no closer than 100 m together to avoid concerns of crowding, given that nesting barrow's goldeneye and buffleheads can be highly territorial (Gauthier and Smith 1987, Savard 1985). We installed nest boxes with the entrance hole facing the water and located approximately 2.5 m above the ground (DUC 2008). When deciduous trees were unavailable, conifer trees lacking low branches and with limited undergrowth were used for box placement. If required, lower and/or overhanging branches were removed to enable suitable access and egress for nesting ducks.

DUC duck box designs were used for this project (DUC date unknown). New pressure-treated lumber was used for the nest boxes, with construction of the boxes occurring away from the deployment locations to avoid releasing treated sawdust to the natural environment (Government of Canada 2019, Lebow and Tippie 2001). A wood screw was used to close the right-side cleanout access door, rather than a pin and wire, to improve box security (please note: a # 2 Robertson screwdriver will be required for conducting future box maintenance). As cavity-nesting waterfowl do not carry nesting material with them, the boxes were lined with 10 to 15 cm of fresh softwood shavings to serve as nesting material (DUC date unknown, DUC 2008).

We attached the boxes to mounting trees using two structural screws: one at the top and one at the bottom. As predator guards had not been installed below nest boxes regionally in the past, including in the Parsnip sub-region, predator guards were similarly not installed beneath the newly installed boxes (Blackbird, personal observation).

The per-box cost to construct the nest boxes based on the DUC design was approximately $25 excluding labour and tools. However, please note that the cost per box is based on the market prices for materials and supplies encountered at the time of material purchase. For the complete cost breakdown, please refer to Appendix C.

4.1.2 Floating Island Design & Site Selection

Floating island locations were similarly selected based on published habitat requirements for local waterfowl species while considering public viewing opportunities, ensuring that locations along publicly accessible roads with available pull-outs were preferentially chosen.

We developed a novel design for the two deployed floating islands to provide functional loafing and/or nesting habitat for waterfowl with enhanced longevity and minimal risks of potential detrimental environmental impacts.

Buoyancy for each island is provided by a manufactured floatation billet. The acquired billets included a wooden board along two top edges to serve as mounting points, with the floatation foam and the board encapsulated in high density polyethylene to provide longevity and prevent foam degradation and dispersion into the surrounding environment.

An aluminum punch plate, with ground edges and corners to prevent wildlife injury, was wrapped in heavy-duty woven coconut matting and bolted to the top of the float. The coconut matting is intended to thermally decouple the surface of the platform from the aluminum sheet, reduce the platform's shine, provide traction for wildlife, retain supplemental platform substrate, and provide footing for any future vegetative cover. The aluminum sheet, as it extends beyond the underlying float, arches into the water on either side to improve waterfowl access and moisture wicking. If required, the sheet ends were further hand-bent during island deployment to ensure it rested below the water level on either side.

We attached eye bolts to opposite corners of a wooden support frame on each island for anchoring, and aviation-grade stainless steel cable was used to attach the eye bolts to concrete anchors. We measured and cut the cable on-site to ensure it was of an adequate length for each island's deployment location, taking into consideration any anticipated water level fluctuations.

At each deployment location, we sourced local materials (soil, organic material, and vegetative matter) and placed in on the top of the island to allow for vegetation establishment in future growing seasons.

For nesting island placement, preference was given to waterbodies which do not see motorized boat use to minimize anthropogenic disturbances to both the islands and nesting or roosting/loafing waterfowl and wildlife.

The per-island cost for materials to construct the islands and anchoring system was approximately $900, excluding labour and final transportation costs. Please note that the cost per island and anchoring system is based on the market prices encountered at the time of purchase. Refer to Appendix C for the complete cost breakdown.

4.2 Community Engagement, Education, and Outreach

Due to COVID-19 and both provincial and federal social distancing guidelines, Blackbird's community engagement, education, and outreach initiatives were adapted to ensure the health and safety of both staff and participants.

We engaged interested classes and families with the Hudson's Hope Elementary and Secondary School (HHESS) to take part in a waterfowl nest box construction project in the spring of 2020. Nest box construction kits, consisting of pre-cut lumber pieces and the required hardware, as well as interactive educational materials covering local waterfowl facts and waterfowl nesting habitat requirements, were prepared by our project team and distributed through the school. We collected the constructed boxes at the end of the summer for subsequent deployment. Interested families provided contact information to receive follow-up details about their nest box and the waterfowl enhancement program.

Local First Nations who had expressed interest in participating in the field program were contacted to determine availability for joining our field crew during nesting box deployment. Saulteau First Nations, through 4Evergreen Resources LP, provided one member to participate in the field program.

A final copy of this report will be provided to each of the First Nations communities who had requested a copy during the initial Notice of Intent discussions.

4.3 Field Program

Following the completion of the desktop review, candidate locations identified as having waterfowl nesting habitat enhancement potential were field scouted to verify suitability. Potential sites were assessed on foot, via boat, and with a remotely piloted aircraft system (RPAS).

Sites were selected based on accessibility (to enable public viewing access and for the ease of future maintenance programs), the availability of existing waterfowl habitat (to ensure enhancement occurs only where required), and general habitat suitability for waterfowl (including waterbody size, depth, food availability, and suitable nesting box mounting tree availability).

Enhancement features were deployed following the identified breeding bird window for the Peace region (ECCC 2018) to avoid any disturbances to nesting waterfowl and to ensure their availability during the 2021 avian migration and breeding season.

5 Results and Outcomes

The waterfowl nesting habitat enhancement program was field scouted in August 2020. Between September 8 and October 7, our field crew led by a qualified environmental professional registered with the BC College of Applied Biology, accompanied by a monitor from Saulteau First Nations, travelled to the identified nest box and floating island locations for enhancement deployment. During this time, a total of 19 artificial nesting structures, including nest boxes and floating islands, were deployed.

5.1 Nesting Box Deployment

Within the FWCP's Dinosaur sub-region, cavity-nesting waterfowl may include bufflehead (*Bucephala albeola*), common and Barrow's goldeneye (*Bucephala clangula, Bucephala islandica*), and common merganser (*Mergus merganser*; Cornell University 2019, Davidson et al. 2015). Cavity-nesting waterfowl are unable to excavate their own tree cavities; they are considered among the secondary cavity users, making use of existing tree cavities (e.g., previously created by woodpeckers, through natural branch break-off, lightning strikes, etc.) for nesting or roosting (Fenger et al. 2006).

Ducks are receptive to using artificial cavities and nest boxes can be used as an effective means to supplement waterfowl habitat, when lacking, provided the features receive regular maintenance (DUC 2008, DUC date unknown, Fenger et al. 2006). Artificial nest box use by waterfowl has been demonstrated during the previous waterfowl nesting habitat enhancement programs implemented within the FWCP's Parsnip Arm sub-region (Ecofor 2015, Juelfs and Corbould 2008). Therefore, Blackbird's goal for the FWCP's Dinosaur sub-region is to supplement nesting habitat availability to increase local waterfowl populations.

We installed seventeen newly constructed boxes at four unique sites throughout the FWCP's Dinosaur sub-region, as described in Table 2 and shown in Appendix B, Figure 1. Each new nest box was lined with softwood shavings for use as nesting material.

In general, healthy mature trees were used to mount nest boxes. However, where healthy trees were unavailable, secure unhealthy or dead trees lacking natural cavities were used for nest box placement.

Table 2: Nest Box Deployment Data

Nest Box #	Site	Tree Species	Box Height (m)	Distance to Water (m)	Aspect	UTM Coordinates (10U)
1	Dinosaur Reservoir	Spruce	3.2	6	S	6203753N 550109E
2	Dinosaur Reservoir	Birch	2.6	25	S	6203221N 559012E
3	Dinosaur Reservoir	Spruce	2.5	7	NW	9203215N 562211E
4	Dinosaur Reservoir	Spruce	2.3	15	E	6203456N 550118E
5	Dinosaur Reservoir	Spruce	2.8	10	NE	6203944N 549595E
6	Dinosaur Reservoir	Spruce	2.4	10	S	6205175N 548597E
7	Dinosaur Reservoir	Spruce	3.5	9	S	6201830N 555567E
8	Dinosaur Reservoir	Spruce	2.7	30	N	6202393N 557604E
9	Dinosaur Reservoir	Birch	2.3	7	S	6203045N 561117E
10	Dinosaur Reservoir	Spruce	2.6	30	NW	6203054N 562741E
11	Dinosaur Reservoir	Spruce	2.2	25	WNW	6203770N 562661E
12	East Wetland Complex	Spruce	2.5	6	NW	6206364N 532126E
13	East Wetland Complex	Spruce	2.5	4	W	6206354N 531946E
14	East Wetland Complex	Spruce	2.6	3	S	6206476N 531976E
15	Centre Wetland Complex	Pine	2.5	4	NW	6205759N 529262E
16	West Wetland Complex	Spruce	2.7	1	W	6205491N 528832E
17	West Wetland Complex	Spruce	2.7	0	WSW	6205410N 528754E

Dinosaur Reservoir, encompassing a portion of the historic Peace River valley between the WAC Bennett and Peace Canyon dams, was noted to have few shorelines, minimal emergent vegetation, and steep surrounding upland areas. As a result, suitable natural nesting locations and, similarly, nest box placement locations were somewhat limited. We installed eleven nest boxes in sheltered coves around the reservoir that were deemed suitable for waterfowl nesting and were visible from the reservoir, for public viewing opportunities (see Appendix B, Figure 2). The surrounding forest was predominately coniferous and, as a result, the boxes were largely mounted on the available conifer trees.

The three unnamed wetland complexes used for placement of the remaining six nest boxes (identified herein as the east, centre, and west complex) are located along the Johnson Creek Forest Service Road between 1.6 and 5 km northeast of Carbon Lake (see Appendix B, Figure 3). These complexes consist of small chains of depressional wetlands located along unnamed stream networks and surrounded by black spruce-dominated forests. The west and centre complexes are joined by the same stream and measure approximately 1.3 ha and 3.0 ha in total size, respectively. The east wetland complex measures approximately 4.1 ha in total size, following along another unnamed stream. Each wetland complex location consists of several connected bodies of shallow open water with graminoid, moss, and willow species growth around the waterbody perimeter followed by forest. Nest boxes were established on stable trees facing toward a water body within these complexes, and the complexes are accessible on foot from the Johnson Creek Forest Service Road for public viewing.

5.2 Floating Island Deployment

Floating islands (also known as artificial nesting islands) have been used historically to provide shoreline and island-nesting waterfowl with nesting habitat to reduce mammalian predation risk, reduce the impacts of flooding where water levels fluctuate regularly, and/or to supplement habitat where natural islands are sparse (Brenner and Mondok 1979, Desorbo et al. 2006, Maggiulli and Dugger 2011, Maxson and Riggs 1996).

Two floating islands were deployed as part of this project at two unnamed areas of permanent shallow open water within the centre and east wetland complexes where nest boxes had similarly been deployment (see Table 3 and Appendix B, Figure 3). The selected waters are not visible from the adjacent forest service road, increasing seclusion and reducing the risk of potential detrimental anthropogenic disturbances. Nevertheless, the waters are easily accessible on foot for public viewing opportunities, with a roadside pullout available near the east complex for safe parking. Within the selected waterbodies, floating islands were placed between 15 and 30 m from shore.

The floating islands are intended for all regional shoreline and island-nesting waterfowl including Canada geese (*Branta canadensis*) and, as island vegetation becomes established and provides cover, mallards (*Anas platyrhynchos*). The islands may also be used by any roosting or loafing waterfowl species and by additional resting aquatic wildlife (e.g., beavers, muskrats, etc.).

Table 3: Floating Island Deployment Data

Island #	Site	Anchor Depth (m)	UTM Coordinates (10U)
A	Centre Wetland Complex	1.3	6205803N 529273E
B	East Wetland Complex	1.4	6206438N 531934E

The deployed islands were of new construction, as detailed in the project methods. Shoreline materials consisting of soil and vegetative debris were placed on the island surfaces to provide nesting materials in the following growing seasons and promote the establishment of graminoid vegetative cover.

The centre wetland complex consists of two adjacent areas of shallow open water with island 'A' deployed in the southernmost waterbody. The selected waterbody is estimated at 1.2 ha in size, within the larger 1.3 ha complex, with tannic water. At the time of installation, the waterbody had a depth of 1.3 m at the island deployment location.

Within the east wetland complex, island 'B' was deployed within the largest of a series of connected small waterbodies draining to the east. The selected waterbody is estimated at 0.8 ha in size within the approximately 3 ha complex, with tannic water and a depth of 1.4 m at the deployment location at the time of installation.

5.3 Community Engagement, Education, and Outreach

A community engagement program was included with this project to increase the local community's awareness of, and interest in, local waterfowl species and the nesting requirements of cavity-nesting ducks.

5.3.1 Hudson's Hope Elementary and Secondary School

We partnered with the staff and students at Hudson's Hope Elementary and Secondary School (HHESS) for construction of the waterfowl nesting boxes. Between May and June 2020, a total of 20 nesting box kits were made available at the school for students to pick up for at-home construction and accompanying activity packages enabled students to learn about local waterfowl and wetlands. Seventeen of these kits were completed, with activities often shared within families, providing an interactive family learning experience for all ages. Supplied participant photos have been included in Appendix A.

Participants with HHESS had the opportunity to provide contact information to receive updates on the project's status. Interested participants were notified following the completion of nest box deployment and were provided with a photo demonstrating a deployed box on Dinosaur Reservoir. The HHESS administration was also provided with a short project update with supporting photos, which was to be included in a November school newsletter.

5.3.2 First Nations Communities

Through the FWCP First Nations Community Engagement process, we had the opportunity to collaborate with available First Nations communities during project implementation. A monitor with Saulteau First Nations assisted with nest box installation and was asked to provide feedback on the perceived project experience and value.

The Saulteau First Nations monitor believed that enhancing waterfowl nesting habitat aligned with his Nation's priorities and values. He expressed satisfaction with the project and expressed a desire to participate in follow-up activities as well as similar projects in the future. Similarly, he believed that his Nation would also like to continue to be involved in the project and to participate in similar projects in the future.

5.3.3 Community at Large

Local community groups were unable to participate in the program due to membership limitations/demographics and social distancing requirements associated with provincial health orders.

6 Challenges & Recommendations

6.1 Waterfowl Nesting Enhancement Structures

We adopted a traditional generic nest box design for this project (DUC 2008, DUC Date Unknown). The traditional design, if constructed well, has a reported life expectancy of up to 25 years (DUC 2008).

For the floating islands, we initially evaluated both traditional wooden islands and modern pre-fabricated floating platforms. To reduce future maintenance costs, we sought easily transportable (i.e., modular), cost-effective, and functional designs for waterfowl which would increase island life expectancy without causing long-term pollution through degradation. Although pre-fabricated designs were initially favoured, they proved to be less cost-effective than anticipated. In the end, we developed a novel design which met the necessary requirements. Based on the selected product specifications, the anticipated life expectancy for the floating islands is approximately 30 years with coir replacement expected approximately every 10 years.

We recommend long-term monitoring of the nesting structures and floating islands to ensure their continued function and value, and to evaluate their continued effectiveness (DUC 2008, DUC Date Unknown, Fenger et al. 2006, Juelfs and Corbould 2008, May 2004, Nelms 2007).

As a novel floating island design was deployed within the project area, and as waterfowl have historically been shown to use floating islands within one year of deployment, we recommend that the floating islands be evaluated one year after deployment following the end of the breeding bird season (i.e., autumn 2021). The purpose of the one-year monitoring review is to determine island integrity and efficacy and to identify any potential future maintenance needs. This monitoring can be accomplished by consultants, community groups, First Nations, etc. who are knowledgeable and trained in the function and value of floating islands as well as how to safely navigate wildlife encounters.

Similarly, we recommend that all deployed structures, including the nest boxes, be maintained and monitored in at least 3-year intervals to determine location suitability, structure efficacy, and to conduct structural and nesting material maintenance when/where required. Although annual nest box maintenance is recommended to promote the highest use rate (DUC Date Unknown, DUC 2008, Fenger et al. 2006, May 2004, Nelms 2007), maintenance and monitoring can occur less frequently depending on climatic conditions and the type of use boxes receive during the winter (DUC 2008, Nelms 2007). The 3-year minimum recommendation considers that newly installed nest boxes are unlikely to be used within the first year following deployment and is consistent with recommendations made for nest boxes installed in the Parsnip Arm sub-region (B. Harrison, DUC, Personal Communication; Clark, 2000; DUC 2008; Juelfs and Corbould 2008). This maintenance and monitoring can also be accomplished by consultants, community groups, First Nations, etc. who are knowledgeable and trained in the function and value of the habitat structures as well as the safe handling of wildlife and how to safely navigate wildlife encounters.

These subsequent monitoring and maintenance programs should include:

- Evaluation of enhancement structure use by both target and non-target species.
- Evaluation of enhancement structure integrity.

- Evaluation of enhancement structure predation rates, as much as feasible, to determine the need for predator guard installations.
- Enhancement structure maintenance such as
    - Replenishing nest box nesting material with fresh wood shavings (please note: a #2 Robertson screw bit will be required to open the nest box cleanout access doors),
    - Relocating structures to more effective locations when little signs of use are evident,
    - Re-anchoring any floating islands that have become detached from their anchoring system,
    - Repairing minor damage to enhancement structures, and
    - Removing or replacing enhancement structures which have experienced significant damage.
- Evaluation of natural habitat availability in the surrounding environment to determine feature necessity.

Separate from the regular nesting feature monitoring and maintenance program, additional monitoring can be completed under the direction of a qualified professional to quantitatively evaluate the impacts the installed artificial nesting structures are having on regional waterfowl population numbers. This will allow for researchers to evaluate not only waterfowl use of artificial features, but also whether the features are having the intended impacts (e.g., an increase in population size) on local waterfowl populations.

6.2 Community Engagement, Education, and Outreach

Community engagement and support opportunities were limited in 2020 due to the COVID-19 pandemic and social distancing guidelines. Volunteers from local community groups were unable to participate in the field program and the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development was unable to provide in-kind field support due to internal social distancing protocols.

Our project delivery plan was adapted to maintain the involvement of HHESS and ensure the safe participation of everyone involved. Nest box construction kits were created in a take-home format and supporting education materials were provided for students and families to complete, increasing their knowledge and awareness of local waterfowl species and cavity-nesting ducks.

During enhancement feature deployment, safety procedures were adapted to ensure the continued health and safety of our field team and First Nations participants, which allowed for the planned participation of available First Nations monitors to continue.

Should social interactions remain restricted during future monitoring and/or maintenance programs, broader community engagement can be continued through digital presentations (e.g., an interactive ‘webinar’ with participating classrooms or for interested community clubs) or through the placement of publicly accessible print materials (e.g., sign(s), laminated posters, and/or pamphlets at the Dinosaur Reservoir boat launch, campground, nearby convenience stations, and/or local visitor information centres).

The inclusion of First Nations monitors in project implementation has been valuable for both our project team and the involved Nations. We recommend that First Nation participation continue through future maintenance and monitoring activities.

It would likewise be valuable to include local environmental clubs and community groups in the program, if feasible, to raise broader awareness on enhancement options, opportunities, and maintenance requirements. Community involvement helps to increase community awareness and interest in waterfowl habitat requirements and can aid in volunteer recruitment for future maintenance requirements.

7 Acknowledgements

The subject Enhancing Waterfowl Nesting Habitat in the Dinosaur Watershed project was completed within the traditional territory of the Treaty 8 First Nations, specifically the Dunne-za, Cree, and Sekani speaking people.

Blackbird Environmental Ltd. gratefully acknowledges the financial support of the Fish and Wildlife Compensation Program for its contribution to the Enhance Waterfowl Nesting Habitat in the Dinosaur Watershed. www.fwcp.ca

We would also like to gratefully acknowledge the support of the following school, communities, and organizations who assisted with this project, *Enhancing Waterfowl Nesting Habitat in the Dinosaur Watershed*:

- Ducks Unlimited Canada, who generously provided in-kind support through nesting structure and floating platform construction designs and advice.
- Hudson's Hope Elementary and Secondary School staff, students, and families who generously volunteered their time to construct the waterfowl nest boxes and enthusiastically participated in the supplied educational programming while maintaining social distancing guidelines.
- Ken Latreille at Mesa Environmental Services for supporting the field crew, providing design and deployment input, often on the fly, on this ever-dynamic project.
- Saulteau First Nations and 4Evergreen Resources LP, whose enthusiastic field monitor provided valuable assistance during nest box deployment.

8 Statement of Limitations

Services provided by Blackbird for this report have been conducted in a manner consistent with the level of skill, care and competence ordinarily exercised by registered members of the profession of biology currently practicing under similar conditions and like circumstances in the same jurisdiction in which the services were provided.

The evaluations contained in this report are based on professional judgement, calculations, and experience. They are inherently imprecise. Biological, physical, and hydrological conditions other than those indicated may exist on the sites.

The recommendations and conclusions contained in this report pertain only to the site conditions observed by Blackbird at the time of the inspection and project implementation. Since site conditions may change over time, this report is intended for immediate use.

The conclusions of this report are based in part on information provided by others. Blackbird believes this information to be accurate but cannot guarantee or warrant its accuracy or completeness.

If you have questions with regards to this report, feel free to contact the authors at your convenience by email at matthias@blackbird.ca or by phone at (250) 793-7262.

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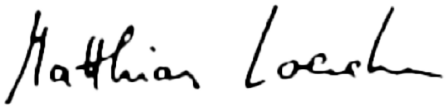

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9 References

Brenner, F.J. and Mondok, J.J. 1979. Waterfowl nesting rafts designed for fluctuating water levels. In The Journal of Wildlife Management, 43(4): 979-982.

Clark, M. 2000. Rocky Marsh Wetland Enhancement Project. PWFWCP Report No. 335. Available: www.env.gov.bc.ca/wildlife/wsi/reports/4794_WSI_4794_RPT_2000_WETLAND.PDF (accessed January 28, 2021).

Cornell University. 2019. The Cornell Lab of Ornithology: All About Birds. Available: https://www.allaboutbirds.org/ (accessed November 24, 2020).

Davidson, P.J.A., Cannings, R.J., Couturier, A.R., Lepage, D., and Di Corrado, C.M. (eds.). 2015. The Atlas of the Breeding Birds of British Columbia, 2008-2012. Bird Studies Canada, Delta, BC. Available: https://www.birdatlas.bc.ca/ (Accessed December 14, 2020]..

Desorbo, C.R., Taylor, K.M., Kramar, D.E., Fair, J., Cooley, J.H., Evers, D.C., Hanson, W., Vogel, H.S., and Atwood, J.L. 2006. Reproductive advantages for common loons using rafts. In Journal of Wildlife Management, 71(4): 1206-1213.

Ducks Unlimited Canada (DUC). Date Unknown. Build a Duck Nest Box. Available: www.ducks.ca/assets/2016/01/duckbox.pdf (accessed November 17, 2020).

Ducks Unlimited Canada (DUC). 2008. Nest Box Guide for Waterfowl. Available: www.ducks.ca/assets/2016/01/nestbox-guide-feb2.pdf (accessed November 17, 2020).

Ecofor Consulting Ltd. (Ecofor). 2015. Artificial Nesting Structure Use and Maintenance. Project # PF15-W16. Available: http://a100.gov.bc.ca/appsdata/acat/documents/r52911/PF15_W16_1508934975060_8934511978.pdf (accessed November 24, 2020).

Environment and Climate Change Canada (ECCC). 2018. Nesting Periods. Available: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html#_zoneB_calendar (accessed November 12, 2020).

Fenger, M., Manning, T., Cooper, J. Stewart, G., and Bradford, P. 2006. Wildlife & Trees in British Columbia. BC Ministry of Forests and Ranch and Lone Pine Publishing: Vancouver, BC.

Fish and Wildlife Compensation Program. 2014a. Peace Basin Riparian and Wetlands Action Plan. Available: https://fwcp.ca/archived-action-plans/ (accessed July 3, 2020).

Fish and Wildlife Compensation Program. 2014b. Peace Basin Plan. Available: https://fwcp.ca/archived-action-plans/ (accessed July 3, 2020).

Gauthier, G. and J.N.M. Smith. 1987. Territorial Behaviour, Nest-Site Availability, and Breeding Density in Buffleheads. Journal of Animal Ecology (56): 171-184.

Government of Canada. 2019. Staying Safe Around Treated Wood. Available: https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/fact-sheets-other-resources/staying-safe-around-treated-wood.html (accessed November 23, 2020).

Holopainen, S., Arzel, C., Dessborn, L., Elmberg, J., Gunnarsson, G., Nummi, P., Poysa, H., and Sjoberg, K. 2015. Habitat use in ducks breeding in boreal freshwater wetlands: a review. In European Journal of Wildlife Resources, 61:339-363.

Juelfs, F.K. and Corbould, F.B. 2008. Wildlife Use and Maintenance of Artificial Nesting Structures established in the Parsnip River Drainage, 1992-2006. PWFWCP Report No. 322. Available: http://a100.gov.bc.ca/pub/siwe/details.do?id=4794 (accessed November 24, 2020).

Lebow, S.T. and Tippie, M. 2001. Guide for Minimizing the Effect of Preservative-treated Wood on Sensitive Environments. General Technical Report FPL–GTR–122. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 18 pp.

Maggiulli, N.M. and Dugger, B.D. Factors associated with dusky Canada goose (*Branta canadensis occidentalis*) nesting and nest success on artificial nest islands of the western Copper River delta. in The International Journal of Waterbird Biology, 34(3): 269-279.

Maxson, S.J. and Riggs, M.R. 1996. Habitat use and nest success of overwater nesting ducks in westcentral Minnesota. In The Journal of Wildlife Management, 60(1): 108-119.

May, H.L. 2004. Artificial Nesting Structures, Wildlife Habitat Council and the US Department of Agriculture Natural Resources Conservation Service, Agricultural Wildlife Conservation Centre.

Nelms, K.D. (Ed). 2007. Wetland Management for Waterfowl Handbook. Mississippi River Trust, Natural Resources Conservation Service, and US Fish and Wildlife Service.

Savard, J.P. 1985. Winter, Spring, and Summer Territoriality in Barrow's Goldeneye: Characteristics and Benefits. Ornis Scandinavica (19): 119-128.

The Royal Society for the Protection of Birds (RSPB). 2020. Nesting Rafts and How to Build Them. Available: https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/advice/conservation-land-management-advice/nesting-rafts/ (accessed December 2, 2020).

Appendix A Photos

Photo 1: Photos of the Swanson family participating in the HHESS nest box construction program (photos supplied by M. Swanson and used with parental permission).

Photo 2: View of floating island B, which was installed within the east wetland complex.

Photo 3: View of nest box # 1 deployed in a spruce tree on Dinosaur Reservoir.

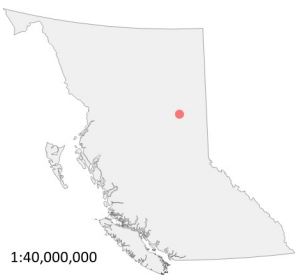
Photo 4: View of nest box # 17 deployed in a spruce tree at the west wetland complex.

Appendix B Mapping

List of Figures

Legend

- Floating Island
- Nest Box
- Roads - Paved
- Stream Network
- FWCP Dinosaur Sub-Region
- FWCP Peace Region
- Lakes & Reservoirs
- Wetland/Riparian



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Disclaimer

UTM Zone 10, NAD 83
Date of data acquisition: Unknown
Data Credit: Blackbird Environmental Ltd., BC Geodata Warehouse
For representational purposes only, all locations are approximate.

Fish & Wildlife Compensation Program

Enhancing Waterfowl Nesting Habitat
Dinosaur Sub-region
Project Overview Map

Horizontal Scale 1:250,000

0 5 10 15 km

Map to scale when plotted on a page 216 mm x 279 mm (Letter)

Our File:	20010	Appl. #:	PEA-F21-W-3223	Revision #:	0
Client File:	n/a	GIS:	KC	Date:	January 29,

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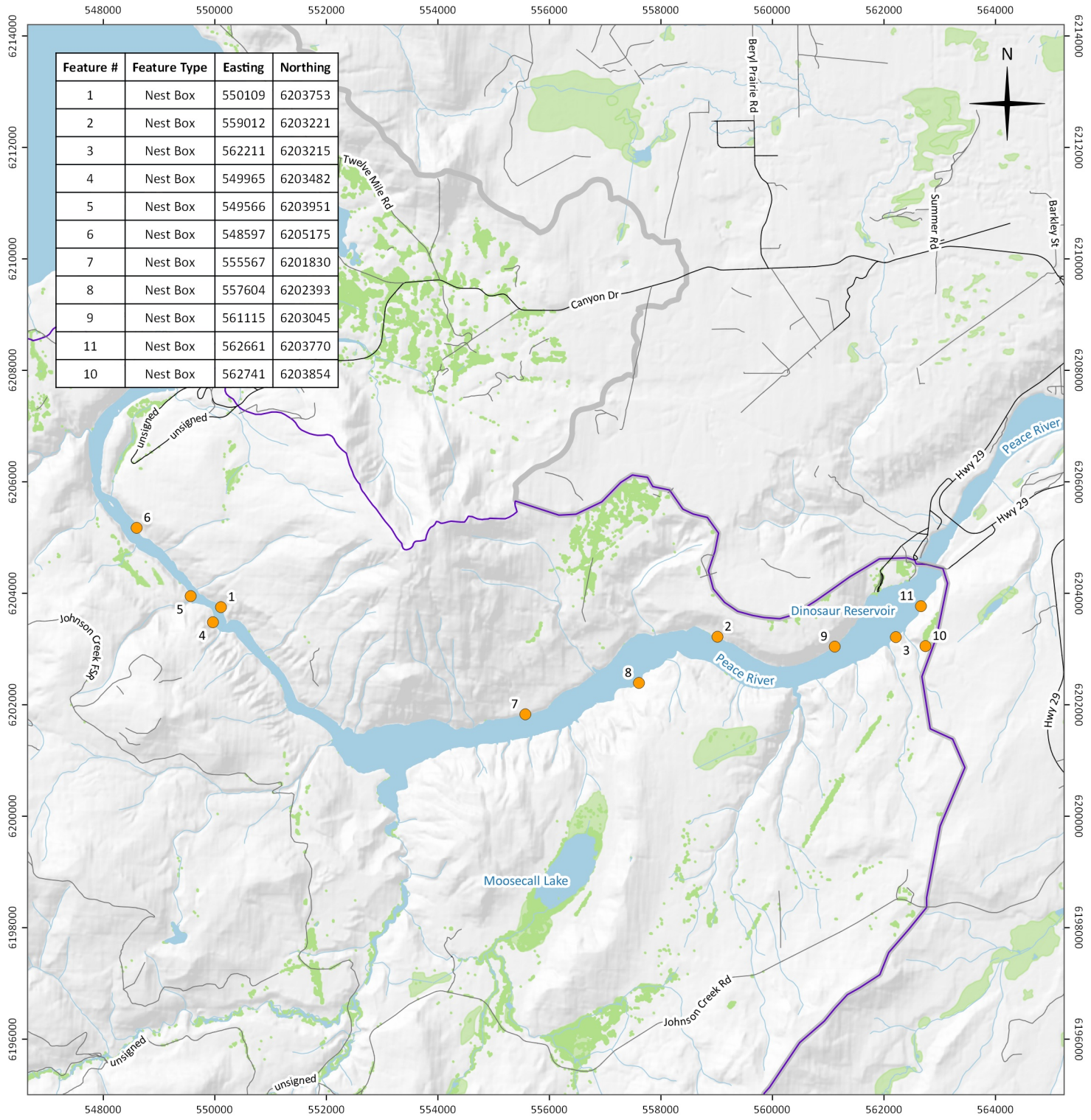
Fort St. John, BC
250.793.7262

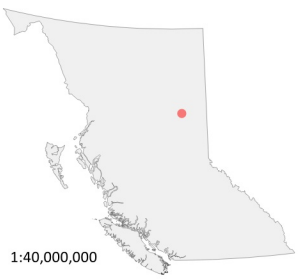
Figure 1



Feature #	Feature Type	Easting	Northing
1	Nest Box	550109	6203753
2	Nest Box	559012	6203221
3	Nest Box	562211	6203215
4	Nest Box	549965	6203482
5	Nest Box	549566	6203951
6	Nest Box	548597	6205175
7	Nest Box	555567	6201830
8	Nest Box	557604	6202393
9	Nest Box	561115	6203045
11	Nest Box	562661	6203770
10	Nest Box	562741	6203854

Legend

- Nest Box
- Stream Network
- Roads - Loose
- Roads - Paved
- FWCP Dinosaur Sub-Region
- FWCP Peace Region
- Lakes & Reservoirs
- Wetland/Riparian



1:40,000,000

Disclaimer

UTM Zone 10, NAD 83
Date of data acquisition: Unknown
Data Credit: Blackbird Environmental Ltd., BC Geodata Warehouse
For representational purposes only, all locations are approximate.

Fish & Wildlife Compensation Program

Enhancing Waterfowl Nesting Habitat
Dinosaur Sub-region
Dinosaur Reservoir Enhancement Feature Locations

Horizontal Scale 1:100,000

0 1 2 3 4 5 km

Map to scale when plotted on a page 216 mm x 279 mm (Letter)

Our File:	20010	Appl. #: PEA-F21-W-3223	Revision #: 0
Client File:	n/a	GIS: KC	Date: January 29,

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Fort St. John, BC
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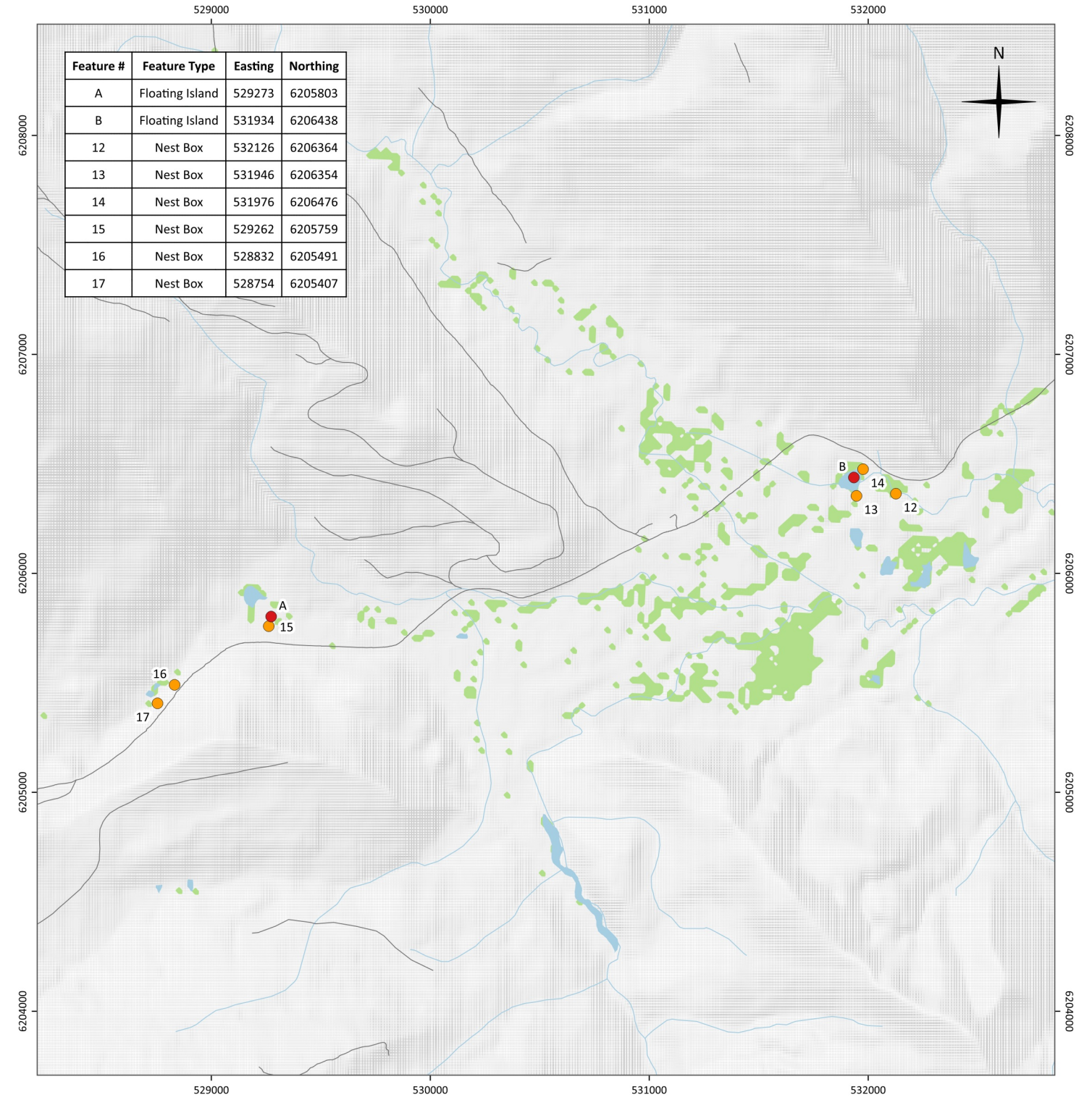
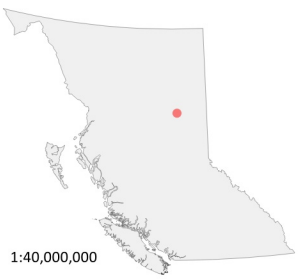
Figure 2



Feature #	Feature Type	Easting	Northing
A	Floating Island	529273	6205803
B	Floating Island	531934	6206438
12	Nest Box	532126	6206364
13	Nest Box	531946	6206354
14	Nest Box	531976	6206476
15	Nest Box	529262	6205759
16	Nest Box	528832	6205491
17	Nest Box	528754	6205407

Legend

- Floating Island
- Nest Box
- Roads - Loose
- Stream Network
- Lakes & Rivers
- Wetland/Riparian



1:40,000,000

Disclaimer

UTM Zone 10, NAD 83
Date of data acquisition: Unknown
Data Credit: Blackbird Environmental Ltd., BC Geodata Warehouse
For representational purposes only, all locations are approximate.

Fish & Wildlife Compensation Program

Enhancing Waterfowl Nesting Habitat
Dinosaur Sub-region
Wetland Complex Enhancement Feature Locations

Horizontal Scale 1:25,000

0 500 1,000 1,500 m

Map to scale when plotted on a page 216 mm x 279 mm (Letter)

Our File:	20010	Appl. #: PEA-F21-W-3223	Revision #: 0
Client File:	n/a	GIS: KC	Date: Nov. 26, 2020

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Figure 3

Appendix C Nest Box and Island Cost Breakdown

Cost Breakdown 1: Nest Box

Component	Cost per Nest Box (including taxes)
Lumber, plywood (treated 3/4") assuming 4 boxes per sheet	$ 15.96
Deck Screws (1 ½ ", 16 total)	$ 5.20
Wooden Dowel Pins (5/16", 9 total)	$ 0.90
Total Cost Per Nest Box*	**$ 22.05**

Cost Breakdown 2: Floating Island

Component	Cost per Island (including taxes and shipping, where applicable)
Island	
4x10' Aluminum Sheet	$ 402.08
Coir Matting (1 roll for 14 islands)	$ 41.27
Float: 1 Enviro Dock Float, 4'x4'x6"**	$ 264.15
Lumber (2x4", 18' total length)	$ 25.19
Nuts (galvanized, 4 total)	$ 1.79
Washers (galvanized, 4 total)	$ 0.54
Structural Screws (¼" x 1 ½", 6 total)	$ 1.95
Structural Screws (5/16" x 3-1/8", 6 total)	$ 19.49
Carriage Bolts (galvanized, 1" x 5", 2 total)	$ 4.70
Eye Bolts (galvanized, 1/2" x 6", 2 total)	$ 11.69
Miscellaneous Supplies (Loctite, 4 large zip ties, etc.)	$ 5.60
	$ 778.45
Anchors	
1/4" cable (approximately 20' total per island)	$ 31.36
5-gallon Plastic Buckets (2 total)	$ 8.89
8" Piling Ring (2 total)	$ 5.78
Concrete (10 gallons)	$ 40.32
Clamps, galvanized (12 total)	$ 7.80
	$ 94.15
Total Cost Per Island*	**$ 872.60**

**Note: These prices are based on the encountered 2020 market prices and include bulk order discounts as well as any applicable shipping costs to Fort St. John, BC.*

*** Enviro Dock Floats were manufactured by Enviro Float Manufacturing (2002) Ltd.*