SAN JUAN COUNTY STORMWATER BASIN PLANNING

VOLUME 1 COUNTY OVERVIEW

Prepared for
San Juan County Public Works

Prepared by
Herrera Environmental Consultants, Inc.

AESI

ESA

Hart Pacific Engineering

Stillwater Sciences



associated earth sciences incorporated

ESA

Stillwater Sciences

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VOLUME 1 COUNTY OVERVIEW

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CONTENTS

Executive Summary xv

Introduction 1

Project Area 3

Relationship to Other Plans and Initiatives 5

- San Juan County Comprehensive Plan 5
  - Water Resource Goals 5
  - Water Resource Policies 5
  - Stormwater Goals and Policies 6
    - Stormwater Goals 6
    - Stormwater Policies 6
- San Juan County Watershed Management Action Plan 7
- San Juan County Stormwater Ordinance 8
- WRIA 2 Salmon Recovery Program 8
- Eastsound Subarea Plan 9
- Drainage Plans 10
  - Eastsound Drainage Plan 10
  - Lopez Village Drainage Plan 10
- Puget Sound Characterization 11

Regulatory Drivers 13

- Growth Management Act 13
- Shoreline Management Act 13
- Clean Water Act 14
- NPDES 16
- Endangered Species Act 17
- Hydraulic Project Approval (HPA) 17
- Groundwater Regulations 17

Environmental Conditions 19

- Climate 19
  - Existing Conditions 19
  - Future Climate Conditions 19
- Topography 21
  - Major Landforms 21
  - Bedrock Hills and Mountains 22
  - Drift Plains 22
  - Coastal Bluffs 22
  - Bluff Classifications 23
- Soils 24

Major Soil Types 24
Hydrologic Soil Groups 25
Erosion Potential 26
Groundwater and Aquifers 26
Groundwater 26
Glacial Aquifers 27
Bedrock Aquifers 27
Critical Aquifer Recharge Areas 27
Water Users 28
Land Use 28
Impervious Cover 29
Infiltration Assessment 30
Surficial Geology 30
Soil Characteristics 32
Selected Infiltration Areas in San Juan County 32
Areas Vulnerable to Stormwater Infiltration 33
Water Quality 33
Reported Stormwater Problems 36

Watershed Resources 39

San Juan Island 39
False Bay 39
Land Use 39
Stormwater Infrastructure 39
Critical Resources 40
Basin Water Quality Evaluation 41
Risk Summary and Management Recommendations 44
Friday Harbor 44
Land Use 44
Stormwater Infrastructure 45
Critical Resources 45
Basin Water Quality Evaluation 46
Risk Summary and Management Recommendations 48
Garrison Bay 48
Land Use 48
Stormwater Infrastructure 48
Critical Resources 49
Basin Water Quality Evaluation 50
Risk Summary and Management Recommendations 51
Griffin Bay 51
Land Use 51
Stormwater Infrastructure 51
Critical Resources 53
Basin Water Quality Evaluation 53
Risk Summary and Management Recommendations 54
Haro Strait 54

Land Use 54
Stormwater Infrastructure 54
Critical Resources 55
Basin Water Quality Evaluation 55
Risk Summary and Management Recommendations 56
Juan de Fuca Strait 56
Land Use 56
Stormwater Infrastructure 56
Critical Resources 57
Basin Water Quality Evaluation 57
Risk Summary and Management Recommendations 57
Mitchell Bay 58
Land Use 58
Stormwater Infrastructure 58
Critical Resources 59
Basin Water Quality Evaluation 59
Risk Summary and Management Recommendations 59
Roche Harbor 60
Land Use 60
Stormwater Infrastructure 60
Critical Resources 60
Basin Water Quality Evaluation 61
Risk Summary and Management Recommendations 61
San Juan Channel (San Juan) 61
Land Use 61
Stormwater Infrastructure 61
Critical Resources 63
Basin Water Quality Evaluation 63
Risk Summary and Management Recommendations 63
Spieden Channel 64
Land Use 64
Stormwater Infrastructure 64
Critical Resources 65
Basin Water Quality Evaluation 65
Risk Summary and Management Recommendations 65
Westcott Bay 66
Land Use 66
Stormwater Infrastructure 66
Critical Resources 67
Basin Water Quality Evaluation 68
Risk Summary and Management Recommendations 68
Orcas Island 69
Deer Harbor 69
Land Use 69
Stormwater Infrastructure 69
Critical Resources 70

Basin Water Quality Evaluation 71
Risk Summary and Management Recommendations 71
Doe Bay 71
Land Use 71
Stormwater Infrastructure 71
Critical Resources 73
Basin Water Quality Evaluation 73
Risk Summary and Management Recommendations 74
East Sound 75
Land Use 75
Stormwater Infrastructure 75
Critical Resources 77
Basin Water Quality Evaluation 78
Risk Summary and Management Recommendations 81
Guthrie and Grindstone Coves 82
Land Use 82
Stormwater Infrastructure 82
Critical Resources 83
Basin Water Quality Evaluation 84
Risk Summary and Management Recommendations 84
North Shore 84
Land Use 84
Stormwater Infrastructure 85
Critical Resources 86
Basin Water Quality Evaluation 86
Risk Summary and Management Recommendations 86
President Channel 87
Land Use 87
Stormwater Infrastructure 87
Critical Resources 87
Basin Water Quality Evaluation 88
Risk Summary and Management Recommendations 88
Raccoon Point 89
Land Use 89
Stormwater Infrastructure 89
Critical Resources 90
Basin Water Quality Evaluation 90
Risk Summary and Management Recommendations 91
West Sound 91
Land Use 91
Stormwater Infrastructure 91
Critical Resources 93
Basin Water Quality Evaluation 93
Risk Summary and Management Recommendations 94
Lopez Island 95
Aleck Bay 95

Land Use 95
Stormwater Infrastructure..... 95
Critical Resources..... 95
Basin Water Quality Evaluation 96
Risk Summary and Management Recommendations 96
Davis Bay 96
Land Use 96
Stormwater Infrastructure..... 96
Critical Resources..... 97
Basin Water Quality Evaluation 98
Risk Summary and Management Recommendations 99
Fisherman Bay 99
Land Use 99
Stormwater Infrastructure..... 100
Critical Resources..... 100
Basin Water Quality Evaluation 101
Risk Summary and Management Recommendations 103
Fisherman Bay Peninsula..... 103
Land Use 103
Stormwater Infrastructure..... 104
Critical Resources..... 104
Basin Water Quality Evaluation 105
Risk Summary and Management Recommendations 105
Hughes Bay..... 105
Land Use 105
Stormwater Infrastructure..... 106
Critical Resources..... 106
Basin Water Quality Evaluation 107
Risk Summary and Management Recommendations 107
Hunter Bay 107
Land Use 107
Stormwater Infrastructure..... 107
Critical Resources..... 108
Basin Water Quality Evaluation 109
Risk Summary and Management Recommendations 109
Iceberg Point..... 109
Land Use 109
Stormwater Infrastructure..... 110
Critical Resources..... 110
Basin Water Quality Evaluation 110
Risk Summary and Management Recommendations 110
Lopez Sound 111
Land Use 111
Stormwater Infrastructure..... 111
Critical Resources..... 112
Basin Water Quality Evaluation 112

Risk Summary and Management Recommendations 113
Mackaye Harbor 113
Land Use 113
Stormwater Infrastructure 114
Critical Resources 114
Basin Water Quality Evaluation 115
Risk Summary and Management Recommendations 115
Mud Bay 116
Land Use 116
Stormwater Infrastructure 116
Critical Resources 116
Basin Water Quality Evaluation 117
Risk Summary and Management Recommendations 119
Outer Bay 119
Land Use 119
Stormwater Infrastructure 120
Critical Resources 120
Basin Water Quality Evaluation 120
Risk Summary and Management Recommendations 121
San Juan Channel (Lopez) 121
Land Use 121
Stormwater Infrastructure 121
Critical Resources 121
Basin Water Quality Evaluation 122
Risk Summary and Management Recommendations 122
Shoal Bay 122
Land Use 122
Stormwater Infrastructure 123
Critical Resources 123
Basin Water Quality Evaluation 124
Risk Summary and Management Recommendations 125
Swift Bay 125
Land Use 125
Stormwater Infrastructure 125
Critical Resources 126
Basin Water Quality Evaluation 126
Risk Summary and Management Recommendations 127
Upright Channel 127
Land Use 127
Stormwater Infrastructure 128
Critical Resources 128
Basin Water Quality Evaluation 129
Risk Summary and Management Recommendations 129
Watmough Bay 129
Land Use 129
Stormwater Infrastructure 130

Critical Resources....130
Basin Water Quality Evaluation....131
Risk Summary and Management Recommendations....131
Shaw Island....131
Land Use....131
Stormwater Infrastructure....132
Critical Resources....133
Basin Water Quality Evaluation....134
Risk Summary and Management Recommendations....134
Populated Outer Islands....134
Land Use....134
Stormwater Infrastructure....134
Critical Resources....136
Basin Water Quality Evaluation....137
Risk Summary and Management Recommendations....137
County-wide Stormwater Management Recommendations....139
Develop Basin Plans for Priority Watersheds....140
Minimize Impervious Cover and Maximize Infiltration....140
Retrofit Ditches and Ponds....142
Maximize Use of Existing Ecological Systems....143
Acquire Property or Easements to Reduce Impacts on Property Owners and the Environment....143
Increase Public Outreach and Education Efforts....144
Support Neighborhood-Based Stormwater Management Solutions....144
References....147

Appendix A Geologic and Soil Information
Appendix B Methods for Land Use Determination and Buildout Impervious Area Calculations
Appendix C Stormwater Basin Planning Web Map Reports

TABLES

Table 1. Summary of Land Uses in San Juan County. 29
Table 2. Sum and Percent of Impervious Cover by Watershed. 31
Table 3. San Juan County Pilot Stormwater Monitoring Program Year 1 (2012–2013) Nutrient Species by Watershed. 36
Table 4. San Juan County Pilot Stormwater Monitoring Program Year 1 (2012–2013) Bacteria Results by Watershed. 36
Table 5. Existing Land Use in False Bay. 39
Table 6. Summary of Aquatic Resources in False Bay Watershed. 41
Table 7. Existing Land Use in Friday Harbor. 44
Table 8. Summary of Aquatic Resources in Friday Harbor Watershed. 46
Table 9. Existing Land Use in Garrison Bay. 49
Table 10. Summary of Aquatic Resources in Garrison Bay Watershed. 49
Table 11. Existing Land Use in Griffin Bay. 52
Table 12. Summary of Aquatic Resources in Griffin Bay Watershed. 53
Table 13. Existing Land Use in Haro Strait. 54
Table 14. Summary of Aquatic Resources in Haro Strait Watershed. 55
Table 15. Existing Land Use in Juan de Fuca Strait. 56
Table 16. Summary of Aquatic Resources in Juan de Fuca Strait Watershed. 57
Table 17. Existing Land Use in Mitchell Bay. 58
Table 18. Summary of Aquatic Resources in Mitchell Bay Watershed. 59
Table 19. Existing Land Use in Roche Harbor. 60
Table 20. Summary of Aquatic Resources in Roche Harbor Watershed. 60
Table 21. Existing Land Use in San Juan Channel (San Juan). 62
Table 22. Summary of Aquatic Resources in San Juan Channel (San Juan) Watershed. 63
Table 23. Existing Land Use in Spieden Channel. 64
Table 24. Summary of Aquatic Resources in Spieden Channel Watershed. 65
Table 25. Existing Land Use in Westcott Bay. 66
Table 26. Summary of Aquatic Resources in Westcott Bay Watershed. 67
Table 27. Existing Land Use in Deer Harbor. 69
Table 28. Summary of Aquatic Resources in Deer Harbor Watershed. 70
Table 29. Existing Land Use in Doe Bay. 72

Table 30. Summary of Aquatic Resources in Doe Bay Watershed. 73
Table 31. Existing Land Use in East Sound Watershed. 75
Table 32. Summary of Aquatic Resources in East Sound Watershed. 77
Table 33. Existing Land Use in Guthrie and Grindstone Coves. 82
Table 34. Summary of Aquatic Resources in Guthrie and Grindstone Coves Watershed. 83
Table 35. Existing Land Use in North Shore. 85
Table 36. Summary of Aquatic Resources in North Shore Orcas Watershed. 86
Table 37. Existing Land Use in President Channel. 87
Table 38. Summary of Aquatic Resources in President Channel Watershed. 88
Table 39. Existing Land Use in Raccoon Point. 89
Table 40. Summary of Aquatic Resources in Raccoon Point Watershed. 90
Table 41. Existing Land Use in West Sound. 91
Table 42. Summary of Aquatic Resources in West Sound Watershed. 93
Table 43. Existing Land Use in Aleck Bay. 95
Table 44. Summary of Aquatic Resources in Aleck Bay Watershed. 96
Table 45. Existing Land Use in Davis Bay. 97
Table 46. Summary of Aquatic Resources in Davis Bay Watershed. 98
Table 47. Existing Land Use in Fisherman Bay. 99
Table 48. Summary of Aquatic Resources in Fisherman Bay Watershed. 100
Table 49. Existing Land Use in Fisherman Bay Peninsula. 104
Table 50. Summary of Aquatic Resources in Fisherman Bay Peninsula Watershed. 104
Table 51. Existing Land Use in Hughes Bay. 105
Table 52. Summary of Aquatic Resources in Hughes Bay Watershed. 106
Table 53. Existing Land Use in Hunter Bay. 107
Table 54. Summary of Aquatic Resources in Hunter Bay Watershed. 108
Table 55. Existing Land Use in Iceberg Point. 109
Table 56. Summary of Aquatic Resources in Iceberg Point Watershed. 110
Table 57. Existing Land Use in Lopez Sound. 111
Table 58. Summary of Aquatic Resources in Lopez Sound Watershed. 112
Table 59. Existing Land Use in Mackaye Harbor. 113
Table 60. Summary of Aquatic Resources in MacKaye Harbor Watershed. 114
Table 61. Existing Land Use in Mud Bay. 116

Table 62. Summary of Aquatic Resources in Mud Bay Watershed. 117
Table 63. Existing Land Use in Outer Bay. 119
Table 64. Summary of Aquatic Resources in Outer Bay Watershed. 120
Table 65. Existing Land Use in San Juan Channel (Lopez). 121
Table 66. Summary of Aquatic Resources in San Juan Channel (Lopez) Watershed. 122
Table 67. Existing Land Use in Shoal Bay. 123
Table 68. Summary of Aquatic Resources in Shoal Bay Watershed. 124
Table 69. Existing Land Use in Swift Bay. 125
Table 70. Summary of Aquatic Resources in Swift Bay Watershed. 126
Table 71. Existing Land Use in Upright Channel. 127
Table 72. Summary of Aquatic Resources in Upright Channel Watershed. 128
Table 73. Existing Land Use in Watmough Bay. 130
Table 74. Summary of Aquatic Resources in Watmough Bay Watershed. 131
Table 75. Existing Land Use in Shaw Island. 132
Table 76. Summary of Aquatic Resources in Shaw Island Watershed. 133
Table 77. Existing Land Use in the Populated Outer Islands. 134
Table 78. Summary of Aquatic Resources in the Populated Outer Islands. 136

FIGURES

Figure 1. Study Area for San Juan County Stormwater Basin Planning Project. 155
Figure 2. Puget Sound Watershed Characterization Management Strategy Matrix. 157
Figure 3. Puget Sound Watershed Characterization Water Flow Assessment Results for San Juan County. 159
Figure 4. Precipitation Measured at the Olga Weather Station by Month. 161
Figure 5. Coastal Bluff Stability of the San Juan Islands. 163
Figure 6. Percent Increase in Impervious Cover from Existing to Estimated Buildout Conditions. 165
Figure 7. Selected Geologic Units within San Juan County. 167
Figure 8. Hydrologic Soil Groups of San Juan County from National Resource Conservation Service. 169
Figure 9. Overlay of Selected Geology with Hydrologic Soils Groups A and B. 171

Figure 10. Map of Ecology 2012 303(d) Impaired Waterbodies and Water Quality Sampling Locations in San Juan County. 173
Figure 11. Overview of False Bay Watershed. 175
Figure 12. False Bay Watershed Basin 1 – Wold Road. 177
Figure 13. False Bay Watershed Basin 2 – San Juan Valley. 179
Figure 14. False Bay Watershed Basin 3 – Frog Song Trail. 181
Figure 15. Overview of Friday Harbor Watershed. 183
Figure 16. Friday Harbor Watershed Basin 1 – Beaverton Valley. 185
Figure 17. Friday Harbor Watershed Basin 2 – Town of Friday Harbor. 187
Figure 18. Friday Harbor Watershed Basin 3 – Kansas Cove. 189
Figure 19. Overview of Garrison Bay Watershed. 191
Figure 20. Garrison Bay Watershed Basin 1 - West Valley Road. 193
Figure 21. Overview of Griffin Bay Watershed. 195
Figure 22. Griffin Bay Watershed Basin 1 - Airport. 197
Figure 23. Griffin Bay Watershed Basin 2 – Burton Lane. 199
Figure 24. Griffin Bay Watershed Basin 3 – Golf Course. 201
Figure 25. Griffin Bay Watershed Basin 4 - Heritage Farm Lane. 203
Figure 26. Overview of Haro Strait Watershed. 205
Figure 27. Haro Strait Watershed Basin 1 - Andrews Bay. 207
Figure 28. Haro Strait Watershed Basin 2 - Westside Lake. 209
Figure 29. Overview of Juan de Fuca Strait Watershed. 211
Figure 30. Juan de Fuca Strait Watershed Basin 1 - False Bay Drive. 213
Figure 31. Overview of Mitchell Bay Watershed. 215
Figure 32. Mitchell Bay Watershed Basin 1 - Blackfish Pond. 217
Figure 33. Mitchell Bay Watershed Basin 2 – Arbutus Lane. 219
Figure 34. Overview of Roche Harbor Watershed. 221
Figure 35. Roche Harbor Watershed Basin 1 - Roche Harbor Resort. 223
Figure 36. Overview of San Juan Channel (San Juan) Watershed. 225
Figure 37. San Juan Channel Watershed Basin 1 – Firwood Lane. 227
Figure 38. San Juan Channel Watershed Basin 2 - Dream and Nave Lake 229
Figure 39. San Juan Channel Watershed Basin 3 – Sportsmans Lake. 231
Figure 40. Overview of Spieden Channel Watershed. 233
Figure 41. Spieden Channel Watershed Basin 1 – Petrich Road. 235

Figure 42. Overview of Westcott Bay Watershed. 237
Figure 43. Westcott Bay Watershed Basin 1 – Roche Harbor Airstrip. 239
Figure 44. Westcott Bay Watershed Basin 2 - Rouleau Road. 241
Figure 45. Westcott Bay Watershed Basin 3 – Roche Harbor Lake. 243
Figure 46. Overview of Deer Harbor Watershed. 245
Figure 47. Deer Harbor Watershed Basin 1 – Channel Road. 247
Figure 48. Deer Harbor Watershed Basin 2 – Deep Meadow Lane. 249
Figure 49. Deer Harbor Watershed Basin 3 – Gaggs Road. 251
Figure 50. Deer Harbor Watershed Basin 4 – Ralph Gott Road. 253
Figure 51. Overview of Doe Bay Watershed. 255
Figure 52. Doe Bay Watershed Basin 1 – Bouy Bay. 257
Figure 53. Doe Bay Watershed Basin 2 – Roehls Hill. 259
Figure 54. Doe Bay Watershed Basin 3 – Doe Bay Road. 261
Figure 55. Doe Bay Watershed Basin 4 – Eagle Lake. 263
Figure 56. Overview of East Sound Watershed. 265
Figure 57. East Sound Watershed Basin 1 – Martin Lake. 267
Figure 58. East Sound Watershed Basin 2 – Ayer Lake. 269
Figure 59. East Sound Watershed Basin 3 – Fowlers Pond. 271
Figure 60. East Sound Watershed Basin 4 – East Sound Village. 273
Figure 61. East Sound Watershed Basin 5 – Crescent Bedach. 275
Figure 62. East Sound Watershed Basin 6 – Ship Bay. 277
Figure 63. East Sound Watershed Basin 7 – Purdue Lake. 279
Figure 64. East Sound Watershed Basin 8 – Youngrens Pond. 281
Figure 65. East Sound Watershed Basin 9 – Cascade Lake. 283
Figure 66. East Sound Watershed Basin 10 – Mountain Lake. 285
Figure 67. East Sound Watershed Basin 11 – Obstruction Pass Road. 287
Figure 68. Overview of Guthrie and Grindstone Coves Watershed. 289
Figure 69. Guthrie and Grindstone Coves Watershed Basin 1 – Victorian Valley. 291
Figure 70. Guthrie and Grindstone Coves Watershed Basin 2 – Killebrew Lake. 293
Figure 71. Guthrie and Grindstone Coves Watershed Basin 3 – Guthrie Cove. 295
Figure 72. Overview of North Shore Watershed. 297
Figure 73. North Shore Watershed Basin 1 - Airport. 299
Figure 74. North Shore Watershed Basin 2 – North Beach. 301

Figure 75. Overview of President Channel Watershed. 303
Figure 76. President Channel Watershed Basin 1 – West Beach. 305
Figure 77. Overview of Raccoon Point Watershed. 307
Figure 78. Raccoon Point Watershed Basin 1 – Day Lake. 309
Figure 79. Raccoon Point Watershed Basin 2 – Terrill Beach. 311
Figure 80. Overview of West Sound Watershed. 313
Figure 81. West Sound Watershed Basin 1 – Lime Quarry Road. 315
Figure 82. West Sound Watershed Basin 2 – Wildrose Lane. 317
Figure 83. West Sound Watershed Basin 3 - Ships Peak West. 319
Figure 84. West Sound Watershed Basin 4 – West Sound Creek. 321
Figure 85. West Sound Watershed Basin 5 - Pinneo Road. 323
Figure 86. West Sound Watershed Basin 6 – Warm Valley. 325
Figure 87. West Sound Watershed Basin 7 – Orcas Village. 327
Figure 88. Overview of Aleck Bay Watershed. 329
Figure 89. Aleck Bay Watershed Basin 1 – Hutton Lane. 331
Figure 90. Overview of Davis Bay Watershed. 333
Figure 91. Davis Bay Watershed Basin 1 - Airport. 335
Figure 92. Davis Bay Watershed Basin 2 – Richardson Road. 337
Figure 93. Overview of Fisherman Bay Watershed. 339
Figure 94. Fisherman Bay Watershed Basin 1 – Lopez Village. 341
Figure 95. Fisherman Bay Watershed Basin 2 – Hummel Lake Road. 343
Figure 96. Overview of Fisherman Bay Peninsula Watershed. 345
Figure 97. Fisherman Bay Peninsula Watershed Basin 1 – Peninsula Road. 347
Figure 98. Overview of Hughes Bay Watershed. 349
Figure 99. Hughes Bay Watershed Basin 1 – Hughes Bay. 351
Figure 100. Overview of Hunter Bay Watershed. 353
Figure 101. Hunter Bay Watershed Basin 1 – Elliott Road. 355
Figure 102. Hunter Bay Watershed Basin 2 – Hunter Bay. 357
Figure 103. Overview of Iceberg Point Watershed. 359
Figure 104. Overview of Lopez Sound Watershed. 361
Figure 105. Lopez Sound Watershed Basin 1 – Bakerview Road. 363
Figure 106. Lopez Sound Watershed Basin 2 – Lopez Hill. 365
Figure 107. Overview of Mackaye Harbor Watershed. 367

Figure 108. Mackaye Harbor Watershed Basin 1 - Mackaye Harbor Road. 369
Figure 109. Overview of Mud Bay Watershed. 371
Figure 110. Mud Bay Road Watershed Basin 1 – Mud Bay Road. 373
Figure 111. Overview of Outer Bay Watershed. 375
Figure 112. Outer Bay Watershed Basin 1 – Flint Road. 377
Figure 113. Overview of San Juan Channel (Lopez) Watershed. 379
Figure 114. San Juan Channel (Lopez) Watershed Basin 1 – Channel Road. 381
Figure 115. Overview of Shoal Bay Watershed.....383
Figure 116. Shoal Bay Watershed Basin 1 – Shoal Bay. 385
Figure 117. Shoal Bay Watershed Basin 2 – Ferry Landing. 387
Figure 118. Overview of Swift Bay Watershed. 389
Figure 119. Swift Bay Watershed Basin 1 – Hummel Lake. 391
Figure 120. Overview of Upright Channel Watershed. 393
Figure 121. Upright Channel Watershed Basin 1 – Odlin Park. 395
Figure 122. Upright Channel Watershed Basin 2 – Southern Area. 397
Figure 123. Overview of Watmough Bay Watershed. 399
Figure 124. Watmough Bay Watershed Basin 1 – Telegraph Bay. 401
Figure 125. Watmough Bay Watershed Basin 2 – Watmough Bay. 403
Figure 126. Overview of Shaw Island Watershed. 405
Figure 127. Populated Outer Islands Watershed Basin 1 – Henry Island. 407
Figure 128. Populated Outer Islands Watershed Basin 2 – Stuart Island. 409
Figure 129. Populated Outer Islands Watershed Basin 3 – Waldron Island. 411
Figure 130. Populated Outer Islands Watershed Basin 4 – Blakely Island. 413
Figure 131. Populated Outer Islands Watershed Basin 5 – Decatur Island. 415
Figure 132. Illustration of How Instream Ponds can Delay and Diminish Stream Flows. 417

EXECUTIVE SUMMARY

The goal of this report is to establish an effective management plan for stormwater in San Juan County (County) to benefit our water supplies, protect property, and support critical natural resource areas such as wetlands and streams, and the species dependent on them. Effective stormwater management means protective stormwater management that is cost effective. Towards this goal, this report initially provides background information on stormwater such as regulatory and planning drivers as well as general characteristics in the County that influence stormwater impacts such as climate, topography, geology, soil types, groundwater and aquifers. Based on a combination of these factors, the report summarizes results from a countywide infiltration assessment to guide future stormwater management opportunities. It then presents a detailed inventory of characteristics for 37 watersheds identified by the County for this study that covers existing and future land use, existing stormwater infrastructure, documented presence of critical natural resources, and detailed information on water quality where data is available. Using this information, specific watersheds are then recommended for additional stormwater management. This report represents Volume 1 of the County's stormwater management plan and addresses stormwater issues countywide. A Volume 2 report will also be prepared to address stormwater issues in the following five watersheds that were previously identified as high priority for stormwater management planning: Garrison/Westcott Bay and False Bay on San Juan Island, Mud Bay and Fisherman Bay on Lopez, and the watershed of the town of Eastsound on Orcas.

In the County, the dominant land use is residential development (37 percent) followed by almost equal areas of undeveloped land and water (26 percent) and resource production (farming and forestry) (24 percent). These statistics are telling and lay the framework for the opportunities and challenges we face managing stormwater in San Juan County.

Impervious cover among County watersheds is relatively low overall. The highest percent of impervious area in a watershed is found within the North Shore of Orcas (which includes most of Eastsound) at 10.2 percent, followed by Friday Harbor at 9.5 percent, and Roche Harbor at 9 percent. Virtually all other watersheds have less than 5 percent impervious area. Future buildout estimates indicate that Friday Harbor and the North Shore of Orcas will continue to have the highest percentages of impervious area. Other currently low and more rural watersheds such as Griffin Bay and Westcott Bay on San Juan, and Raccoon Point and West Sound on Orcas will become increasingly impervious predominantly from residential development. All County watersheds will exceed the lowest 5 percent threshold documented as an indicator of stream degradation and approximately half will exceed the higher threshold of 10 percent impervious.

A preliminary assessment of the suitability of particular areas in San Juan County for infiltration of stormwater indicates a number of places where infiltration may be feasible including within the North Shore watershed of Orcas, parts of Mitchell Bay, Garrison Bay, and Griffin Bay on San Juan, and Lopez Village in the Fisherman Bay watershed. However, the

County area with high infiltration potential is significantly reduced when the permeability of the underlying geology is used to further screen infiltration potential, leaving smaller and fewer areas including the North Shore, Griffin Bay, and Lopez Village. Although the method to overlay NRCS soils data with surficial geology likely provides the best regional-scale information available to identify county areas with the greatest infiltration potential, in-depth records research and site specific field explorations would be required to determine whether soil, geologic, and groundwater properties are truly conducive to infiltration; especially given the coarse scale of the databases used. Moreover, other areas not identified in the infiltration assessment may have localized conditions that would in fact support high infiltration.

A number of water quality monitoring programs have been undertaken by San Juan local and regional entities in recent decades. While not fully inclusive, data from these programs provide background information on several of the major pollutants found in stormwater or urban runoff. Review of water quality data for San Juan County suggests that water quality is supportive of Ecology designated beneficial uses regarding water temperature, dissolved oxygen, pH, and turbidity. Exceptions include five locations, which are included on the Ecology 2012 303(d) list as "waters of concern" (Category 2) or "impaired" waterbodies (Category 5) with respect to these parameters. Several common stormwater constituents have been found at low levels or are non-detectable, including total and dissolved metals (arsenic, cadmium, lead, zinc), total petroleum hydrocarbons (TPHs), and three herbicides/pesticides commonly used on the islands (permethrin, MGK-264, and glyphosate). Total copper may be somewhat elevated at particular sites, but overall, is generally similar to recently reported median values for Puget Sound Phase 3 monitoring (Ecology and King County 2011). Based on San Juan County Pilot Stormwater Monitoring Program 2012–2013 data, all dissolved metals are below Ecology acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in San Juan County stormwater with respect to metals. Anionic surfactants are far below USEPA criteria for drinking water sources. Nutrient concentrations are low to moderate compared with values measured in Puget Sound Phase 3 monitoring and reported in three national databases of monitored stormwater concentrations (Stillwater 2014). In contrast to other stormwater constituents, bacteria (i.e., fecal coliform and *Escherichia coli*) are generally elevated in San Juan County stormwater.

San Juan County prepared a web-based site for citizens to report stormwater management problems called the Stormwater Basin Planning Web Map found at http://sjcgis.maps.arcgis.com/home/item.html?id=cd645b044c5445e3a3799ce94e1d0524. As of this report, 127 problems were entered into the database. Of these, the vast majority were in the watersheds with urban growth areas. The East Sound watershed had the highest number of stormwater problems with 33 percent of the total reported followed by Friday Harbor with 10 percent. The North Shore of Orcas watershed followed next with 8 percent. The village of Eastsound encompasses portions of both the East Sound and North Shore of Orcas watersheds and accounts for the location of close to 41 percent of all stormwater complaints. Over 70 percent of the problems reported directly related to high stormwater flows and included reports of flooding, erosion, and ponding. Four percent of the complaints related to observed water quality problems. Thirteen percent of the complaints classified their complaint as damage to property; the majority of these were on private property. The

County is concerned over how to solve stormwater problems that are the result of private development not constructed to common or regulatory standards.

Given the existing predominantly rural and semi-rural character of our island landscapes, we have a greater opportunity to provide long-term protection for high value water resources affected by stormwater management than more urbanized communities do. Effective stormwater planning and management support this opportunity. However, most of the development occurring in San Juan County is small, residential, and falls below the current regulatory thresholds for required stormwater treatment or flow control. Development without treatment and flow control contributes to an ongoing challenge: continuing aggregate increases in stormwater flows and the consequent strain on both constructed and natural stormwater, wetland, and stream systems. The planning process offers methods and actions that manage stormwater on a watershed scale that accounts for the aggregate impact.

Adding to that challenge is that incoming development is the focus of regulation; however, existing development may have a far more serious impact on property and the environment. For example, the periodic flooding that occurs in Eastsound after large storms is the product of existing development that occurred under less protective regulations. Jurisdictions large enough to be covered under a National Pollutant Discharge Elimination System (NPDES) permit can require improvements to stormwater flow control and treatment when redevelopment occurs but San Juan County falls below this federal regulatory threshold. Consequently, current opportunities to ensure that existing and future development in the County properly manage stormwater are limited, will likely need to rely heavily on voluntary participation, and improvements will be fueled more by community outreach, education, training, and partnerships rather than by regulation. This report identifies the following countywide recommendations for effective and protective stormwater management.

- **Develop Basin Plans for Priority Watersheds**: We can reasonably expect property owners along those drainages currently experiencing flooding and drainage problems to be further affected by flooding and loss of developable property as additional land is developed. Other nearby wetlands and drainages may have capacity and could benefit from more stormwater flow. Because stormwater management is determined on a project-by-project basis without benefit of a landscape-level understanding of water flow and watershed conditions, there is currently no avenue for watershed-based stormwater management solutions that could relieve stormwater pressure in some areas of a watershed while accommodating it in others. Developing watershed-specific basin plans would help provide that context.

- **Minimize Impervious Cover and Maximize Infiltration**: From a community perspective, each development project that includes impervious cover and ties into the public stormwater system contributes to the potential for water resource impairments and the cost of maintaining public infrastructure. To date, San Juan County has an overall very low impervious cover percentage and with the exception of watersheds with urban areas such as Friday Harbor, Eastsound, and Roche Harbor, impervious area is not yet, in most watersheds, a significant stressor to stream and wetland conditions. However, coastal communities such as ours rely on our proximity to water for economic vitality through fishing, tourism, and water dependent

activities. In addition, shorelines are scenic and desirable places for people to live. Consequently, the marine shoreline areas of our watersheds tend to have higher impervious cover than inland watershed areas. Higher impervious area combined with potentially poor stormwater management in shoreline areas can further compound flooding threats to property and resources during heavy storms. In addition, all aquifers in the County are recharged by the infiltration of precipitation, therefore land use and stormwater management practices that affect runoff, infiltration, and pollutant loading can affect the quality of groundwater resources. Careful management of stormwater to promote infiltration and maintain high surface and groundwater quality is essential.

- **Retrofit Ditches and Ponds**: Ditches are the primary stormwater conveyance in San Juan County. Altering ditches to be wider and flatter would significantly improve their water quality treatment functions and they could be altered to slow flows as well. Poorly designed ditches can increase stormwater flow velocity, which causes erosion and subsequent sedimentation that can adversely affect downstream waterbodies. Ponds can be beneficial in that they detain stormwater and capture some pollutants. They are used for recreation and many are important for livestock watering. However, ponds also allow for higher rates of evaporation, have low plant diversity, which substantially reduces their water quality treatment effectiveness, and they can affect both the timing and volume of instream flows in County creeks. These issues could be improved through strategic purchases of land or drainage easements that would allow the County to retrofit ditches or ponds to improve stormwater treatment and flow conditions within the broader landscape.

- **Maximize Use of Existing Ecological Systems**: Use of natural systems for stormwater management can keep the public cost of stormwater management low through use of existing wetlands, ponds, streams, swales, and ditches to manage stormwater. Connecting wetlands, swales, and ditches can create networks that would sustainably improve water quality treatment and reduce flows at relatively low cost; this could be especially effective in agricultural areas. Use of natural systems for stormwater management can be accomplished without degrading our resources through careful basin planning and monitoring.

- **Acquire Property or Easements to Reduce Impacts on Property Owners and the Environment**: Drainage solutions identified from basin planning efforts may point to acquiring property or drainage easements on private property for improved stormwater management. Drainage easements would allow for County control over stormwater where needed to protect property from flooding or losses to critical area resources from increased frequency of high stormwater flows.

- **Increase Public Outreach and Education Efforts**: Because most land development in the County is for single-family residential housing, proactive outreach to new and existing residential property owners is recommended. Outreach programs could include education, training, and technical assistance on best practices for managing onsite stormwater, pond development, herbicide and pesticide use, home maintenance chemicals, agricultural operations, forestry practices, and animal waste

control. Research has shown public outreach and education can be quite successful (Nowacek et al. 2003).

- **Support Neighborhood-Based Stormwater Management Projects**: Measures that encourage stormwater projects sponsored by neighborhood groups and communities could provide innovative implementation of stormwater management solutions. The County would offer technical assistance and potentially some funding to assist. Neighborhood-based solutions could produce creative projects that provide multiple benefits and meet local needs.

INTRODUCTION

San Juan County Public Works (County) is committed to effective stormwater management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County seeks to address these potential issues proactively at two primary levels:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends countywide stormwater management strategies (Phase 1)
- A second level evaluation that provides a more detailed review of conditions in five priority watersheds, including Eastsound and Lopez Village, and identifies land use planning and capital improvement project alternatives to address specific stormwater issues in these areas (Phase 2)

This report constitutes the documentation of the first Phase 1 level evaluation of the County overall. It covers most of San Juan County's populated islands (Figure 1) including 37 separate watersheds or combinations of watersheds. This information will enable the County to plan efficiently for needed strategies, initiatives, and capital improvement projects for all watersheds and most immediately, the watersheds to be studied in more detail in Phase 2.

We understand that addressing existing stormwater problems and planning now for future land uses will allow increased development to occur without jeopardizing environmental quality. Commensurate with this understanding, the goal of this project is to ensure the County complies with the Growth Management Act (GMA) and Washington State water quality standards while establishing a pathway towards sustainable stormwater management that will protect San Juan County's natural environments. Effective management of stormwater benefits our water supplies, protects property, and supports critical natural resources. Effective stormwater management means protective stormwater management that is cost effective.

This report is organized to provide background information pertinent to countywide stormwater management. It begins by summarizing regulatory drivers for stormwater management and a discussion of how other plans and initiatives affecting San Juan County relate to stormwater management. Then general characteristics such as climate, geology, soil types, information on groundwater, aquifers, and including an infiltration assessment of the County are presented. These discussions are followed by a detailed inventory of watershed characteristics for 37 watersheds identified by the County for this study. The inventory includes land use, existing stormwater infrastructure, documented presence of critical natural resources, and detailed information on water quality where data is available.

PROJECT AREA

San Juan County is an archipelago comprising four major islands (San Juan, Orcas, Lopez, and Shaw) and over 170 smaller islands. There are no major rivers in the county, but there are over 400 miles of marine shoreline, as well as lakes and streams. This study covers most of San Juan County's populated islands (Figure 1) and includes 37 separate watersheds or combinations of watersheds that constitute separate watershed planning areas.

Relationship to Other Plans and Initiatives

Stormwater management is addressed in a number of County past and present planning efforts as well as the state sponsored WRIA 2 Salmon Recovery Plan and the Washington State Department of Ecology (Ecology) Puget Sound Characterization initiative. The following sections describe the specific aspects of these initiatives related to stormwater management. Such efforts indicate that although regulations are a driver for stormwater management, in San Juan County community values are another dominant incentive. This is supported by the fact that San Juan County has an appointed a Citizens Stormwater Advisory Committee (CSWAC) to oversee the County's efforts to proactively improve stormwater management and to represent public views on resource protection.

San Juan County Comprehensive Plan

Under the Growth Management Act, the County's development regulations must follow the goals and policies adopted in the San Juan County Comprehensive Plan. Certain Water Resource Goals and Policies in Section B, Element 4 provide guidance for the management of stormwater. The following goals and policies are those most relevant to water resource protection and stormwater management.

Water Resource Goals

- In consideration of Best Available Science, protect & manage the quality and quantity of ground and surface water to preserve hydrologic systems, designated beneficial uses, and fish and wildlife habitat that rely on fresh water.
- Coordinate water planning and protection efforts among San Juan County departments with authority over development, land use, drinking water, wastewater treatment, stormwater management, road construction and maintenance, solid waste management, and natural resource protection.

Water Resource Policies

- Assess and manage cumulative impacts so that predevelopment water quality, quantity, infiltration, and runoff rates can be protected.
- Ensure that future development will not harm surface and groundwater resources and the habitat dependent on them.
- Encourage the retention of healthy native soils, vegetation, and forest cover. Encourage preservation and increased infiltration of fresh water.
- Support environmentally responsible, sustainable forestry and agricultural practices that protect water quality and enhance infiltration of runoff.

- Establish and support technical assistance programs to help property owners protect ground and surface water and associated habitat.
- Practice adaptive management. Consider new information as it becomes available, and revise water resource protection programs as necessary.
- In decision making, utilize locally adopted policies and water resource analysis meeting the Best Available Science Standard.
- Encourage voluntary enhancement such as rainwater catchment, stormwater retention and other technologies that will benefit water quality and quantity related to this element.

Stormwater Goals and Policies

The following introduction and goals are from the Comprehensive Plan Section 4.2.C Stormwater Goals and Policies.

> *Stormwater poses a widespread risk to the health of our island watersheds. Forests produce the least runoff, the greatest amount of infiltration, and the best water quality. Soil compaction, altering drainage patterns, and replacing forest with pasture, lawn, driveways, and structures results in less infiltration, more surface runoff, and if not controlled, the discharge of warm, polluted water. As the amount of runoff increases, less water is available for beneficial uses including drinking water.*
>
> *Increasing surface runoff also increases the quantity of pollutants that are swept into the water during storms. The removal of riparian vegetation and over grazing by livestock destroys nature's filtration system, which can result in runoff, sediment, and nutrients flowing unimpeded into the water. Developing an area can also expose more pollutants to stormwater.*

Stormwater Goals

- Prevent flooding and property damage.
- Promote groundwater recharge.
- Protect the quality of ground and surface water.

Stormwater Policies

- Promote water conservation and the concept of stormwater as a usable resource.
- When feasible, treat, manage, and infiltrate stormwater on site, as close to impervious areas and sources of pollution as possible. Allow off site discharge only as a last resort with mitigation.
- When stormwater management ponds are necessary, ensure they are sited and designed to comply with the WA Dept. of Fish and Wildlife requirements, to maintain

predevelopment runoff patterns, to protect water quality, and to prevent increases in water temperature.

- Ensure that clearing, grading and stormwater management regulations and enforcement programs:
    - Prevent flooding and property damage, protect fish and wildlife habitat, and protect the quality and quantity of surface and groundwater in a cost effective manner.
    - Establish criteria that identify sites and projects with a low risk to property, water resources, and associated habitat.
    - Ensure that property owners can prepare and implement their own stormwater management plans on low risk sites and low risk projects.
    - Incentivize the use of Low Impact Development techniques.
    - Guidance documents that may be used in the management of stormwater include but are not limited to the Low Impact Development Technical Guidance Manual for Puget Sound, 2005 and the Rain Garden Handbook for Western Washington Homeowners, and the Stormwater Management Manual for Western Washington.
    - Develop or adopt a stormwater management manual suitable for rural counties.
- Develop cost effective technical assistance programs for property owners.
- Complete watershed based management plans that assess and provide mitigation options for the cumulative impacts of land use and development.
- When necessary, identify and construct cost effective, publicly owned infrastructure designed to prevent harm to property, water resources, and associated habitat.
- Provide incentives and cost share programs for landowners willing to install community stormwater management systems that implement Best Management Practices (BMPs).

San Juan County Watershed Management Action Plan

The San Juan County Watershed Management Action Plan was developed by the Watershed Management Committee, comprising volunteer citizens, between 1997 and 1999 and adopted by the then Board of County Commissioners (now called the County Council) on June 21, 2000. A primary driver of the action plan is to identify areas where stormwater is causing pollution or hydrologic changes that are adversely affecting resources. The goals of the plan are:

- Reduce and eliminate nonpoint sources of pollution including pathogens, toxic contaminants, sediment, and nutrients from the waters of San Juan County and Puget Sound.
- Develop county policies that manage water resources, by protecting existing water rights, by protecting and enhancing flows and habitat for water-related wildlife and fish, and by providing for the public health and well-being of the county.

- Develop a watershed management plan that includes realistic objectives and durable solutions that reflect the diversity of the watersheds and island communities and will survive political change.

To support these goals, the Watershed Management Committee developed objectives for reducing pollution from onsite septic systems, agricultural practices, forestry practices, marinas, and stormwater runoff. Objectives of the plan for stormwater runoff include:

- Set up programs offering education, incentives, and technical assistance to homeowners to prevent residential pollution from on-site septic systems, landscape management, and stormwater runoff.
- Recommend best management practices for stormwater, agriculture, clearing and grading to be implemented through new development codes.

The plan details countywide strategies for implementing improvements to water quality and for improved ongoing stormwater management. The watersheds used in that plan are similar but are not the same as those used for this stormwater basin planning study.

San Juan County Stormwater Ordinance

For stormwater management of new and redevelopment, San Juan County references the 2005 Washington State Department of Ecology Stormwater Management Manual for Western Washington. This manual provides guidance on the measures necessary to control the quantity and quality of stormwater produced by new development and redevelopment so runoff is compliant with water quality standards and stormwater management is protective of the beneficial uses of the receiving water. The manual establishes minimum requirements for projects of all sizes, and provides guidance concerning how to prepare and implement stormwater site plans. The minimum requirements identified in the manual are satisfied by the application of Best Management Practices (BMPs). In addition, the BMPs identified in the January 2005 Low Impact Development Technical Guidance Manual for Puget Sound, produced by the Puget Sound Action Team, are acceptable alternatives for managing runoff, controlling soil erosion, and maximizing and protecting recharge. Note that there is now an updated 2012 Ecology stormwater management manual, however the County has opted to still direct users to the 2005 manual.

WRIA 2 Salmon Recovery Program

Effective stormwater management is considered crucial to the long-term health and recovery of Puget Sound salmon. This is because pollution in stormwater is the leading contributor to water quality pollution of waterways and because high stormwater flows can harm fish habitat by widening streams, eroding banks, and depositing excessive sediment (PSP 2013).

San Juan County is the Lead Entity for salmon recovery in Water Resource Inventory Area (WRIA) 2, and has designated the San Juan County Marine Resources Committee (MRC) to be the Lead Entity citizen based organization for managing salmon recovery for the county. The Lead Entity Program leverages local resources to protect and restore ecosystem habitats and processes utilized by salmon. The Lead Entity Program, with technical assistance from

University of Washington Friday Harbor Labs, state and federal agencies, and consultants, establishes the strategy for salmon recovery work, sets the goals, and creates the project work plan. The Lead Entity Program also ensures local projects are funded and completed, and is an advocate for salmon utilizing the waters of the San Juans.

All twenty-two populations of Puget Sound Chinook salmon use County nearshore waters for feeding on their way to the sea and on their return. Although, there are no known natural Chinook spawning areas in the islands, sockeye, pink, chum and coho salmon, and steelhead and coastal cutthroat trout have all been documented in the County's marine waters.

An ongoing planning objective in the San Juan County Salmon Recovery Chapter of the Puget Sound Salmon Recovery Plan (SSPS 2007) is to work "in concert with existing local, regional, and state salmon recovery efforts". The County's stormwater drainage systems, and stormwater management, planning, and regulations represent existing tools that can contribute to salmon recovery. Developing and implementing stormwater basin plans can directly affect nearshore habitats and water quality.

The 2013 to 2015, 3-year work plan for WRIA 2 salmon recovery (PSP 2013) includes non-capital projects aimed at improving water quality. In addition, incorporating drainage basin plans into the County's comprehensive plan and ordinances was identified as a Priority Tier I habitat protection project.

Eastsound Subarea Plan

The Eastsound Subarea Plan is currently being updated. The amended plan describes the purposes of the plan:

- Identify, conserve, and enhance the qualities of Eastsound that contribute to people's enjoyment of the place as well as to its functions as the commercial, cultural and residential center of a rural island community and ensure that land uses which adjoin residential uses are compatible with them.
- Anticipate and manage how change will occur in Eastsound and immediate surroundings, and to provide a tangible vision for future growth so that the qualities that define its character and give it value as a place to live and work are not compromised as growth and change are accommodated.
- Provide clear standards for development in Eastsound including standards for buildings, streets and sidewalks, utilities, lighting and allowable uses within each land use district.
- Assure that all Eastsound specific code and land use requirements are considered in the county's Unified Development Code (UDC), Title 18.
- Assure that local Eastsound residents play a role in defining the character and growth of the Eastsound Subarea.

The Eastsound Subarea Plan recommends that the County develop a Stormwater Management Plan for Eastsound that recognizes "the natural limitations and benefits of the Eastsound

swale to detain and filter runoff from streets, parking areas and other impervious surfaces." It says, "The Eastsound swale is both a distinctive feature of the community and a critical filter for surface water runoff into East Sound. The permanent viability of water quality in East Sound, particularly in and near Fishing Bay, depends on maintaining this wetland function." To support that, the plan recommends that the County pursue a Clean Water Fund Grant for development of a nonpoint pollution control plan for East Sound that includes stormwater management recommendations to protect marine water quality and the functions of the swale. It also recommends that the County acquire rights to manage the Eastsound swale as part of an Eastsound stormwater system via easements or fee simple acquisition.

Drainage Plans

There are two County drainage plans covering the villages of Eastsound and Lopez that were both completed in 2005.

Eastsound Drainage Plan

The Eastsound Drainage Plan was completed in May 2005. Its purposes were:

- Provide a basis for a Comprehensive Stormwater Management Plan for the Eastsound Urban Growth Area (Eastsound UGA).
- Provide an interim plan to guide the orderly development and management of stormwater drainage within the Eastsound UGA.

Make available data and information that combined with a supplementary implementation and finance report would meet GMA requirements for stormwater planning in the Eastsound UGA.

The plan delineated and analyzed 10 basins contributing stormwater flows to East Sound and made recommendation s for drainage improvement projects within each based on local conditions and known problem areas. In addition, the drainage plan outlined a Stormwater Improvement Plan that addressed the following issues:

- Outfall and conveyance improvements that affect large areas
- Wetland preservation strategies including wetland bypasses that will limit increased flows to wetlands
- Treatment systems that will improve the quality of stormwater runoff discharged to East Sound and Category 1 wetlands in the UGA
- Selected projects that mitigate flooding and erosion in local areas
- Monitoring programs that would provide baseline data on how area wetlands function and provide feedback on the health of area wetlands and receiving waters

Lopez Village Drainage Plan

The Lopez Village Drainage plan had similar overall goals as the Eastsound Drainage plans and included:

- Provide a long-range plan for the future development of drainage facilities to serve the Lopez Village UGA.
- Provide a Drainage Analysis and Plan to satisfy the drainage-related requirements of the Growth Management Act (GMA).
- Provide a plan to serve as a basis for the adoption and implementation of a Comprehensive Drainage Plan for Lopez Village.
- Ensure that the planning and construction of public drainage facilities and services within Lopez Village keep pace with anticipated development and are available for use without decreasing current service levels below locally established minimum standards.

The Lopez Village Drainage Plan analyzed six drainage basins that contribute flow to seven outfalls and made recommendations for corrective actions to improve flow and flood conditions and water quality.

Puget Sound Characterization

The Puget Sound Characterization is a set of spatially explicit water and habitat based watershed assessments that compare areas within a watershed in terms of their relative suitability and value for restoration and protection (Stanley et al. 2011). The assessments cover water resources (both water flow and water quality) and fish and wildlife habitats in terrestrial, freshwater and marine nearshore areas over the entire drainage area of Puget Sound. The assessment for water flow combines results from different models that evaluate the "importance" and "degradation" of small watersheds, referred to as Assessment Units (AUs), regarding the following water-flow processes:

- **Delivery**: The Delivery model assesses those physical features that control how precipitation is delivered to the landscape. This includes the quantity of precipitation, area of forest cover, and rain on snow zones.
- **Surface Storage**: The Surface Storage model assesses those features that control the movement of water at the surface, including depressional wetlands and floodplains.
- **Recharge**: The Recharge model assesses areas that control the infiltration and percolation of precipitation into groundwater.
- **Discharge**: The Discharge model assesses areas that control the movement of groundwater back to the surface, including the area of slope wetlands and floodplains with permeable deposits.

The importance and degradation rankings from these models are integrated into a matrix that defines broad management strategies for any AU (Figure 2). The greatest level of management action (broadly denoted "Restoration") applies to the most important AUs for restoring water resource functions but that also have the greatest existing degradation. Conversely, areas of lower importance due to less degradation likely require a much lower level of management attention (here termed "Conservation"). Those with high importance for

restoring water resource functions and low existing degradation may need little or no active management but warrant a high level of protection to maintain high functional conditions; and those with low importance and significant human impact would be lowest in priority ranking for active management. These are tagged "Development," indicating that additional development in this AU will have the lowest overall impact relative to other AUs regarding water-flow processes.

Results for individual AU's from the water flow assessment could identify general stormwater management strategies for broad areas of the County. Figure 3 shows the locations of these AUs with the watershed planning units used for this report and their corresponding management strategy recommendations.

The results indicate the following broad patterns observed among the County's watersheds:

- Large areas of the County are categorized as Highest Restoration and Restoration indicating they are important areas for maintaining watershed functions and are in a degraded state. These include the majority of lands encompassed by the following watersheds: False Bay, Griffin Bay and Friday Harbor on San Juan Island; Deer Harbor, West Sound, and North Shore on Orcas; and Fisherman Bay, Swift Bay, most of Lopez Sound and Hughes Bay on Lopez Island. Many are dominated by agricultural land uses.

- Few areas of the County are categorized as Highest Protection. Highest Protection indicates landscapes that are both important for maintaining watershed functions and are not degraded, therefore they should be protected. Most Highest Protection areas are on the outer islands, Shaw Island, and within watersheds where little development affecting water flows has occurred.

- In general, the watershed areas categorized as Development/Restoration by the model do not accurately reflect actual conditions. Development/Restoration would indicate areas that have highly degraded watershed functions and low importance. Most of the Development/Restoration area shown on Figure 3 may occur in areas that have low importance for water resource functions but, in general, they have low intensity rural development and relatively intact ecosystem functions.

The Puget Sound Characterization produces coarse scale results derived from analyses of data for the entire Puget Sound Basin. The results of the characterization should be augmented with more detailed finer scale information locally produced (Stanley et al. 2011). Local data will be integrated with the Puget Sound Characterization results in Volume 2 of this report that addresses stormwater impacts in a subset of priority watersheds in more detail. The augmented results from the Puget Sound Characterization will provide a decision framework that guides the development of water resource management strategies at the reach scale in these watersheds.

REGULATORY DRIVERS

The County is complying with several state and federal regulations related to protecting or improving water resource conditions. With other requirements, these regulations call for the County to maintain or improve surface and groundwater water quality and manage stormwater runoff volumes to protect aquatic habitats. The primary regulatory drivers related to the County's goals for managing stormwater are summarized below.

Growth Management Act

In 1990, the Washington State (state) legislature passed the Growth Management Act (GMA) establishing planning goals and a planning framework for cities and counties. The GMA requires San Juan County to prepare 20-year comprehensive plans that address land use, rural use, housing, capital facilities, utilities, and transportation. More broadly, a comprehensive plan is a statement of the community's vision for the future regarding the natural and built environments. In keeping with this idea, the GMA also established 13 planning goals to guide the preparation of local comprehensive plans and regulations. Under these goals, local governments are to direct most growth into urban areas, require adequate transportation facilities for new development, protect natural resource lands and environmentally critical areas, encourage economic development, and protect property rights.

GMA planning activities are also intended to be coordinated with other state acts that set forth policies and regulations for the control of water pollution in the state, most notably the Washington Pollution Control Act (WPCA) (see description in Clean Water Act subsection below). For example, RCW 36.70A.020(1) states that comprehensive plans must "protect the environment and enhance the state's high quality of life, including air and water quality." Washington State Department of Commerce (DOC) regulations (WAC 365-195-700) also state: "for local jurisdictions subject to its terms, the Growth Management Act mandates the development of comprehensive plans…these plans and regulations will take their place among existing laws relating to resource management, environmental protection, regulation of land use, utilities and public facilities. Many of these existing laws were neither repealed nor amended by the [GMA] act."

The County's latest updates to the comprehensive plan were approved in 2009. In response to GMA requirements for periodic plan review, each update provides a planning framework for activities through 2030.

Shoreline Management Act

Washington's Shoreline Management Act (SMA) was passed by the legislature in 1971 and affirmed by voters in 1972. Under the SMA, each county with Shorelines of the State must prepare and adopt a Shoreline Master Program (SMP) that is based on state laws and rules but is tailored to the specific geographic, economic, and environmental needs of the community. The overarching goal of the SMA is "to prevent the inherent harm in an uncoordinated and

piecemeal development of the state's shorelines." The SMP identifies allowable activities and uses within shoreline areas. The SMP must also establish antidegradation policies to prevent the loss of functions associated with ecosystem-wide processes as well as localized processes that can significantly affect shoreline natural resources as well as human health and safety. As such, SMP regulations may include prescriptive measures for management of stormwater.

The SMA applies to all cities and counties that have Shorelines of the State (RCW 90.58.030(2)) within their boundaries. Shorelines of the State include land areas extending 200 feet landward from the edge of:

- All marine waters
- Streams and rivers with greater than 20 cubic feet per second mean annual flow
- Lakes 20 acres or larger
- Wetlands and river deltas when associated with one of the above

The County is currently updating its SMP, which was last adopted and approved by Ecology in 2002. The County's Shorelines of the State include all marine shorelines and freshwater shorelines on 12 lakes. There are no County streams large enough to be a Shoreline of the State.

Clean Water Act

Established in 1972, the federal Clean Water Act (CWA) requires the identification and cleanup of polluted surface waters, and establishes water quality standards for surface waters throughout the United States. In addition, the CWA regulates discharges to surface waters by requiring National Pollutant Discharge Elimination (NPDES) permits for discharges to receiving waters from municipal, industrial, and other regulated point and "nonpoint" (diffused and dispersed across the landscape) sources (see more detailed discussion in *NPDES* subsection below). Sections of the CWA also require preparation of a list of impaired waterbodies (Section 303(d) list) and permit approvals, such as Section 401 Water Quality Certifications, to ensure CWA standards are met. Within Washington State, the US Department of Environmental Protection (USEPA) has delegated administration of these CWA requirements to the state. In addition, the state regulates water quality through the Washington Pollution Control Act (WPCA).

Surface water quality standards for the state are established in Chapter 173-201A of the Washington Administrative Code (WAC) (Ecology 2006). The purpose of these standards is to designate "beneficial uses" for surface waterbodies and establish chemical and physical criteria for protecting these uses. Beneficial uses include public water supply; protection for fish, shellfish, and wildlife; and recreational, agricultural, industrial, navigational and aesthetic purposes. Use designations for waterbodies in Washington are listed in WAC 173-201A-600 and 173-201A-602. There are different water quality standards for freshwaters (streams, rivers, and lakes) and marine waters. The surface water quality standards also establish an antidegradation process that helps prevent unnecessary lowering of water quality, and provides a framework to identify those waters designated as an "outstanding resource" by the state.

The Section 303(d) list of impaired waterbodies is periodically updated by Ecology and submitted to the USEPA for review and approval. Ecology submits these lists on a 2-year alternating cycle for the freshwater listing and the marine water listing. At the time of this report, the USEPA approved the marine Water Quality Assessment 305(b) report and current 303(d) list on December 21, 2012.

In developing the Section 303(d) list, Ecology identifies five categories of water quality health:

- **Category 1**: Meets Tested Standards for Clean Waters
- **Category 2**: Waters of Concern
- **Category 3**: Insufficient Data
- **Category 4**: Polluted Waters that require no Total Maximum Daily Load (TMDL) limit of targeted pollutant(s) to achieve the surface water quality standards. Three subcategories are:
    - **Category 4a**: Has an approved TMDL study in place
    - **Category 4b**: Has a pollution control program in place being implemented and is expected to comply with state water quality standards
    - **Category 4c**: Is impaired by a non-pollutant
- **Category 5**: Polluted waterbodies that require a TMDL

Category 5 waterbodies are placed on the state's 303(d) list of impaired waterbodies. Under CWA requirements, the state must perform a TMDL study for all Category 5 waterbodies identified on the Section 303(d) lists. A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet the water quality standards. A TMDL identifies the allowable loads of a single pollutant from all point and nonpoint sources and determines a margin of safety to ensure that the waterbody can be protected in case there are unknown pollutant sources or unforeseen events that may impair water quality. The process of calculating and documenting a TMDL typically involves a number of tasks, including characterizing the impaired waterbody and its watershed, identifying sources, setting targets, calculating the loading capacity using some analysis to link loading to water quality, identifying source allocations, preparing a TMDL report, and coordinating with stakeholders (USEPA 2008). TMDL implementation is also a complex process that involves applying the pollution control practices to reduce the pollutant loads to the extent determined necessary in the TMDL. These practices usually comprise point source control permits or nonpoint source control BMPs. Completing all these tasks is costly and time consuming, often requiring years to finish just the TMDL study and implementation plan.

Given this consideration, the USEPA and Ecology (2011) have established a process that allows local communities to forgo the formal TMDL planning process if they create a program to clean up polluted waters. Because these programs are locally controlled, there is an opportunity to reduce overall costs, and the communities can exert greater control over the

cleanup process. Once a pollution control program is in place and being successfully implemented to address a source of impairment for a Category 5 waterbody, it can be designated a Category 4b waterbody on the Section 303(d) list, indicating a TMDL is no longer required.

Under surface water standard for Washington State, surface waters in the County are to be protected for the designated uses of salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values. The most recent 303(d) list for marine and freshwaters identifies several impaired Category 5 waterbodies in the County (see more detailed description in *Watershed Resources* section). The exceedances of water quality criteria are dissolved oxygen (DO) in East Sound and San Juan Channel, bacteria concentrations in several unnamed tributaries to other waters and in San Juan Valley Creek (also known as False Bay Creek), and total phosphorus (TP) in Horseshoe Lake.

NPDES

The NPDES permitting program was developed to control the discharge of point sources of pollution such as from pipes and sewers to the nation's waters and is the primary regulatory vehicle for management of stormwater quantity and quality impacts on surface waters (40 Code of Federal Regulations [CFR] 122.26(d)). The USEPA has delegated administration of the NPDES program to the state.

In response to the 1987 amendments to the CWA, which included regulation of stormwater discharges under the NPDES permitting program, Phase I of the program was initiated in 1990 and requires medium and large cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges. In 1999, Phase II of the program was initiated and requires smaller cities and counties with lower populations to obtain NPDES permit coverage for their stormwater discharges.

Because the USEPA has delegated administration of these CWA requirements to the state, Ecology administers the Phase I and Phase II NPDES programs for municipal stormwater. Ecology also administers programs for controlling construction, industrial, and highway stormwater discharges through issuing the following NPDES general waste discharge permits:

- Construction Stormwater General Permit (CSWGP)
- Industrial Stormwater General Permit
- Sand and Gravel General Permit; and Boatyard General Permit
- WSDOT Municipal Stormwater General Permit

Due to its population, San Juan County is not a designated municipal NPDES permittee. Although Ecology does not require San Juan County to obtain an NPDES stormwater discharge permit, development activities must still comply with federal state water pollution control laws. However, Ecology encourages non-permittee communities such as ours to adopt

stormwater regulations and best management practices equivalent to those adopted in their approved stormwater manual.

Endangered Species Act

The Endangered Species Act (ESA) was enacted to protect the Nation's heritage in fish, wildlife, and plants from extinction. In addition, the habitat upon which endangered and threatened species depend may be conserved. The ESA addresses stormwater management to ensure that potential adverse impacts on receiving waters from discharges of sediment, abnormal pH, or turbidity, which can degrade habitats and harm aquatic life, are avoided or minimized. Listing aquatic species (such as Chinook salmon or bull trout) under the ESA requires that the water quality of streams, wetlands, lakes, and marine waters be protected. ESA regulatory provisions that address stormwater management include the Section 4(d) rules, Section 7 consultations, and Section 10 Habitat Conservation Plans (HCP).

Hydraulic Project Approval (HPA)

The Hydraulics Act established in Chapter 77.55 RCW authorizes the Washington State Department of Fish and Wildlife (WDFW) to regulate stormwater discharges from a project that would use, divert, obstruct, or change the natural flow or bed of any of the salt or freshwaters of the state through issuing a Hydraulics Project Approval (HPA) permit. All construction projects in state waters must obtain an HPA before commencing work. Examples of work covered include installing a floodgate, dredging, or removing a beaver dam.

Groundwater Regulations

Groundwater quality protection standards for the state are defined by Ecology in Chapter 173-200 WAC (Ecology 2010). The goal of the standards is to maintain groundwater quality and to protect existing and future beneficial uses through the reduction or elimination of contaminants discharged to the subsurface. Similar to the CWA, state groundwater regulations establish the following antidegradation policies:

- Existing and future beneficial uses shall be maintained and protected and degradation of groundwater quality that would interfere with or become injurious to beneficial uses shall not be allowed.
- Degradation shall not be allowed of high quality groundwaters constituting an outstanding national or state resource, such as waters of national and state parks and wildlife refuges, and waters of exceptional recreational or ecological significance.
- Whenever groundwaters are of a higher quality than the criteria assigned for the waters, the existing water quality shall be protected, and contaminants that will reduce the existing quality thereof shall not be allowed to enter such waters, except where it's demonstrated to the department's satisfaction that:
    - An overriding consideration of the public interest will be served.
    - All contaminants proposed for entry into said groundwaters shall be provided with all known, available, and reasonable methods of prevention, control, and treatment prior to entry.

State law also sets requirements for wellhead protection programs (WAC 246-290-130 and 246-290-135 [Ecology 2011c]). Wellhead protection programs, which are required for all large or public drinking water wells, are a proactive approach to preventing contamination of groundwater used for drinking water supplies. Wellhead protection programs identify potential sources of groundwater contamination, implementing strategies to prevent degradation, and managing existing sources of contamination to ensure actions have been taken to protect the drinking water supply. In Washington, local wellhead protection programs must specifically include:

- A completed susceptibility assessment
- A delineated Wellhead Protection Area for each well, well field, or spring
- An inventory of potential contaminant sources in the Wellhead Protection Area that could threaten the water-bearing zone (aquifer) used by the well, spring, or well field
- Documentation showing the water system owner sent delineation and inventory findings to required entities
- Contingency plans for providing alternate drinking water sources if contamination does occur
- Coordination with local emergency responders for spill or incident response measures

The County has a wellhead protection program under this requirement. San Juan County has nearly 180 public and private water systems. The larger systems (Town of Friday Harbor, Roche Harbor, Eastsound, Rosario, and Doe Bay) rely mostly on surface water. The remaining systems utilize wells as their dominant water source. All of these wells have wellhead protection zones. Nearly all, except for Eastsound, base their protection areas on concentric circles placed around the wellhead.

Last, Ecology requires all injection wells, including stormwater infiltration wells (Class V wells), to be registered through the Underground Injection Control (UIC) program. This program requires all owners and operators of UIC wells to perform a self-assessment to safeguard groundwater from being contaminated by pollutants. There are no known injection wells in San Juan County.

ENVIRONMENTAL CONDITIONS

This chapter summarizes existing watershed conditions within the County including climate, topography, geology, soils, groundwater, and the County's aquifer resources. It also provides an assessment of stormwater infiltration potential and an overview of water quality conditions in San Juan County.

Climate

Stormwater infrastructure, whether it is in pipes, ponds, or rain gardens, is typically designed to convey or capture runoff flows associated with a design storm, the magnitude of which is based on the frequency and size of observed rainfall events. Thus, climate conditions directly affect stormwater management strategies and the selection of best stormwater management practices needed to control flows, promote infiltration, and preserve and enhance water quality.

Existing Conditions

The climate of the County is maritime and characterized by cool dry summers and moderately wet winters (Orr et al. 2002; Klinger et al. 2006). From nearly 120 years of observations, the National Weather Service gage at Olga reports that temperature has averaged 57.1°F over that time period, with an all-time record high of 93°F measured in July 2009 and a record low of -8°F in January 1950 (Western Regional Climate Center 2014). Figure 4 shows the monthly precipitation variability throughout the year based on the rainfall record between 1891 and early 2013. Annual precipitation at Olga has varied between 15 and 38 inches, with an average of 29 inches. Only 6.7 inches of snow falls on average each year at Olga, one of the snowier places in the County (Western Regional Climate Center 2014). Spatially, precipitation varies significantly throughout the County, with Mount Constitution being by far the wettest area, receiving over 48 inches of rain on average per year (Orr et al. 2002). Southern areas on San Juan Island and Lopez Island are the driest areas, averaging less than 20 inches per year near American Camp (Klinger et al. 2006; San Juan County 2000). The variation in rainfall indicates geographic differences, which can create microclimates of more or less precipitation depending on position in the landscape – commonly referred to as the "rain shadow" effect.

Future Climate Conditions

The potential hydrologic changes associated with climate change increase the importance of stormwater management practices that control flows, promote infiltration, and preserve and enhance water quality. Recent climate trends across much of the country indicate large rainfall events are occurring with greater frequency, casting doubt on whether stormwater infrastructure designed by our current design storm approach can be expected to provide the intended level of service throughout its lifetime.

There remains significant uncertainty regarding what influence climate change will have on local precipitation patterns. Projected changes in annual precipitation, averaged over all climatic models, are small (1 to 2 percent), but most models project an enhanced seasonal cycle with changes toward wetter autumns and winters, and drier summers (Mote and Salathé 2010). Some models show significant seasonal shifts, especially towards wetter autumns and winters and drier summers, and at least one regional model indicates that fall precipitation will increase less in the San Juans than elsewhere in Western Washington (Littell et al. 2009). Average projected winter increases in precipitation are not large relative to interannual variability (Littell et al. 2009). Projections of extreme precipitation events also vary significantly, but generally indicate increases in extreme rainfall magnitudes throughout the state in the future (Littell et al. 2009).

With climate change, ensuring infiltration of stormwater and groundwater recharge will become increasingly prominent because the County's water resources are precipitation driven and much of the County's water supply is from groundwater and impounded lakes. As groundwater demands increase (due to higher temperatures and greater population), and especially if water resources become more scarce (due to altered precipitation patterns and higher temperatures), maximizing stormwater infiltration and storage in the landscape will gain increasing importance.

There are several recent reports in the scientific literature addressing climate change impacts on the Pacific Northwest that have information relevant to stormwater management. Climate change has been shown to increase stream temperatures (particularly in the summertime: Mantua et al. 2010), compromise habitat restoration success (Battin et al. 2007), change the hydrology of stream basins (Elsner et al. 2010), increase wave energy (Allan and Komar 2006) and increase sea level (Canning 2005; Mote et al. 2008). While some of the climatic responses discussed in these works are not pertinent to San Juan County (i.e., the predicted reduction in seasonal snowmelt), others, such as increased summer stream temperatures are likely to have significant effects (Mantua et al. 2010). Alterations to basin hydrology cited by most depend on changes to the gradual transition from spring snowmelt to fall runoff typical of Cascadian rivers (Elsner et al. 2010). However, snowmelt is a very small contributor to seasonal stream flow in San Juan County (Western Regional Climate Center 2014), so these effects are likely to be inconsequential.

There are also oceanographic changes associated with climate change, which will affect some areas of the County significantly including sea level change and heightened wave setup. Sea level change is produced by the combined effects of global sea level rise and local factors, such as vertical land deformation (e.g., tectonic movements) and seasonal water surface elevation changes due to atmospheric circulation effects (Mote et al. 2008). With San Juan County, there is net tectonic uplift (Verdonck 2006), which reduces the overall effect of global sea level (Canning 2005; Mote et al. 2008), which should be factored into any assessment of sea level rise (US Army Corps of Engineers 2011). This explains the relatively modest sea level rise observed at Friday Harbor in the twentieth century of 1.13 millimeters per year (NOAA 2011). Also suppressing recent historical sea level rise are large-scale oceanographic processes, the reversal of which may trigger acceleration of sea level rise soon (Bromirski et al. 2011). It is important also to couch these changes in terms of interannual sea level variability associated with El Niño. Mojfeld (1992) has shown that during El Niño years

the average water level can be up to 1 foot higher than in ordinary winters. It is unclear whether and if so, how this effect will change.

Heightened wave setup also plays a role. For instance, heightened wave setup, a physical process by which wave energy raises the mean level of the sea can, over time, increase extreme wave heights and thus average sea level during storm events in areas where swell is present (swell is the result of large waves produced in the open ocean). Because these effects depend on large open-ocean-derived waves, sea levels would only likely increase where swell is typically present, such as along the southwestern shoreline of San Juan Island and the southern portions of Lopez Island.

The NOAA Sea Level Rise and Coastal Flooding Impacts Viewer (http://csc.noaa.gov/digitalcoast/tools/slrviewer) provides a visual interactive online tool that helps to identify potential areas of inundation due to rising sea level. This information will be helpful when planning for and designing stormwater infrastructure in areas that may be vulnerable to sea level change.

One of the main effects from any net rise in sea level in San Juan County would be an increase in the frequency of marine flood events and subsequent storm-related damage that may affect stormwater infrastructure along shorelines. Such a change would also affect high tide levels and could increase shoreline erosion rates along beaches and bluffs (Shipman 2009). High tides may also compromise the efficacy of stormwater infrastructure (King County 2008). Increases in erosion rates coupled with more frequent flooding would likely increase pressure to further armor shoreline roads and outfalls, which could have a detrimental cumulative effect on nearshore biota (Herrera and The Watershed Company 2011).

Topography

Topography is the arrangement of natural and artificial physical features of an area. Topography largely determines the direction and extent of drainages conveying stormwater runoff. It also is a driver of erosion potential in the landscape along with soil type. The elevation and topographical changes evident in the varied topography of the San Juan Islands also present challenges to stormwater management. For example, the steep slopes that define our mountains such as Cady Mountain on San Juan Island or Buck Mountain on Orcas Island require a far different approach to managing stormwater than areas where a deep soil cover exists on a flat plain or slowly rolling hills such as on much of Lopez Island. Local conditions of slope, topography, and physiographic character are part of the stormwater management deliberation.

Major Landforms

Topography in the San Juan Islands falls into three categories: steep bedrock hills and mountains, drift plains of glacial sediment underlain by bedrock, and coastal bluffs. Most bluffs in the County are composed of resistant bedrock, but some are comprised of a vertical sequence of glacial sediments or a combination of glacial deposits over bedrock (Shipman et al. 2010).

Overall, the San Juan Islands lie in a broad trough known as the Puget Lowland. The Lowland extends from the Fraser Valley in British Columbia to the Willamette Valley in Oregon and from the Olympic Mountains on the west to the Cascade Range on the east. The area has been subjected to several episodes of glacial advance and retreat. Near the northern extent of the Puget Lowland, San Juan County is dominated by bedrock outcrops varying in elevation from sea level to over 2,400 feet above sea level, partially overlain by deposits from glaciers that intermittently occupied the region over the past 2.4 million years (Blunt et al. 1987). The morphology of the land surface today is largely a result of erosion and deposition during and since the retreat of the last continental glaciation (about 15,000 years ago). Modern postglacial streams and glacial meltwater channels have cut troughs and valleys up to several hundred feet deep into the Puget Lowland, manifested in the San Juan Islands as the channels between and around islands. Elongate north-south trending hills and swales parallel the flow direction of an ice sheet that occupied the Puget Lowland about 15,000 years ago. The morphology of these features plays an important role in the distribution and groundwater flow of a shallow regional aquifer.

Bedrock Hills and Mountains

Stormwater typically runs over bedrock, rather than infiltrating into the subsurface. This is important to understand when making stormwater management decisions because the San Juan Islands are comprised primarily of bedrock with many outcrops exposed at the surface of the islands and at coastlines, forming steep sea cliffs. The steep, rocky hills originated during the Late Cretaceous because of a thrust-faulting orogeny (Brandon et al. 1988), and repeated glaciations have carved and modified the bedrock to present day topography. Bedrock landforms are typically resistant to weathering and mass wasting events, despite steep topography.

Drift Plains

The hydrologic properties of drift plains vary as the drift itself varies spatially; however, in general, drift plains have at least some stormwater infiltration potential. This landform is prominent in central Orcas Island, southeastern San Juan Island, and western Lopez Island. The last glacial episode, the Vashon Stade of the Fraser glaciation, saw the San Juan Islands covered by an ice sheet. This resulted in the deposition of glacial sediment such as outwash, drift, and till, over much of the County, particularly lower-elevation areas. Undifferentiated glacial drift soils mantle much of lowland San Juan County, forming broad, flat plains.

Coastal Bluffs

Though bedrock bluffs are relatively stable and form steep cliffs along the island's shorelines, wind, wave action, and precipitation are constantly shaping and eroding the sedimentary bluffs of the San Juan Islands. Bluff conditions are mapped for the County, however some shoreline properties require additional evaluation of bluff conditions, when present, to ensure safe and effective stormwater management. This is because many small shoreline basins have unstable bluffs and associated erosion hazards not captured by our databases.

Effective stormwater management is critical in coastal bluff areas to prevent bluff collapse and landslides. Coastal bluff collapse is governed by numerous factors, though geology,

hydrogeology, and slope are the most significant. Most landslides in the Puget Sound region occur in response to either heavy precipitation or elevated groundwater conditions (Thorsen 1987). Typically, landslides occur where permeable soils, such as sands and gravels, lie directly on top of less permeable materials such as silts, clays, or bedrock. This causes a perched water table to develop and overlying soils to become locally saturated (Tubbs 1974). A common occurrence of this in the San Juan Islands is where glacial sediments overlie bedrock. Heavy groundwater loading in the glacial sediments increases pore pressures, leading to slope weakness and ultimately slope failure. Uncontrolled infiltration of stormwater in close proximity to steep slopes can exacerbate this problem.

Another slope failure mechanism is erosion of the bluff toe by wave action, which ultimately leads to steepening of the slope and the increased likelihood of failure. Toe erosion can be a slow process in the San Juan Islands as many coastal areas are protected from high wave energy. Consequently, although wave action and undercutting rarely directly cause landslides, they may set the stage for future slope failures (Shipman 2010). Toe erosion is more significant and often the dominant erosive process on the periphery of the archipelago, where larger waves are more common. Seismic events may also act as the trigger for deep-seated coastal landslides.

Bluff Classifications

Ecology's Coastal Atlas Map (Ecology 2014) is a collection of mapped coastlines and slope failure hazards within Washington State. Areas within about 2000 feet of the sound are mapped and categorized based on slope and landslide hazard into one of six categories: stable, intermediate, unstable, unstable recent landslide, unstable old landslide, and modified land. Definitions of each of these classifications are presented in the Coastal Zone Atlas (Ecology 2014) and are:

- **Stable**: Stable slopes rise less than 15 percent in grade, except in local areas of low groundwater concentration or competent bedrock. Inherently weak materials, such as peat or weathered till, are included in this category as well provided they have no significant slope.
- **Intermediate**: Intermediate slopes are steeper than 15 percent except where conditions such as weaker material and/or abundant groundwater exist. Identified areas include slopes of sand and gravel, till, or thin soils over bedrock which have no known failures.
- **Unstable**: Unstable slopes are unstable because of geology, groundwater, slope and/or erosional factors. They include areas of landslides and talus too small or obscure to be individually mapped.
- **Unstable Recent Landslides**: Identifies recent or historically active landslide areas. Note this designation is based on investigations carried out in the late 1970s; subsequent landsliding is not reflected on the maps within the Coastal Zone Atlas and more coastal bluffs may fall into this category than have been mapped.
- **Unstable Old Landslides**: Identifies post-glacial but prehistoric landslide areas.

- **Modified**: Modified slopes are highly modified by human activity and include areas of significant excavation or filling. Slope response to a combination of natural processes and human activities may be unpredictable.

The distribution of these zones is mapped and displayed on Figure 5. Of particular note are the areas mapped as "unstable". Excess hydraulic loading in these areas, such as from a nearby stormwater infiltration facility, has the potential to contribute to a landslide, more so than in other areas marked as stable.

The topographic conditions one sees are a reflection of the underlying geology through weathering by wind, rain, alternations of heat and cold temperatures, running water, and the fretting of the tides. Essentially, where natural physical conditions persist, topography is an expression of geologic history. For more information on the geology of the San Juan Islands, please see Appendix A.

Soils

Soil provides a number of functions that are critical to effective stormwater management including the ability to store water and nutrients, moderate flows, and neutralize pollutants. The disturbance, compaction, and degradation of soils from human activity impacts soil structure and reduces its ability to provide these functions. When native soils are removed or eroded, soil organic content is reduced, soil structure declines, and the biological activity of the soil decreases — all resulting in poorer water filtration and holding capacity. Soil erosion in stormwater runoff contributes to degraded water quality and compromised aquatic habitat in nearby streams from sedimentation.

Major Soil Types

The appearance and properties of soils are a result of the interaction of five soil-forming factors—parent material, climate, topography, biological factors, and time. Soils in San Juan County have been mapped by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS). Soil scientists create the surveys by observing the steepness, shape, and length of slopes, the general pattern of drainage, vegetation, and the bedrock. They dig holes to study soil profiles down to the parent material below the rooting zone of the vegetation to soil not changed by biological activity (NRCS 2005). The soils are then grouped into map units of similar characteristics including depth to restrictive layer, drainage class, and depth to water table.

The Soil Survey of San Juan County generalizes soils by categorizing them into one of five characteristic settings: valleys of glacial drift plains, glacial drift plains, hills of glacial drift plains, glacial drift plains and hills, and hills and mountains. Each setting is described by representative soil types within it. Appendix A provides additional detailed information on soil types and the characteristics settings where they are found.

The bedrock and glacial history of the San Juan Islands have played an important role in the development of surface soils, and subsequently strongly influences both county- and basin-scale soil hydrologic properties. Soils in San Juan County are formed over relatively young glacial deposits or glaciated bedrock surfaces and have not had sufficient time to develop the

deep weathering profiles present in soils of many unglaciated terrains. That translates into few areas of the County having deep soil profiles with high infiltration capacity. The great variability in bedrock translates to a wide variety of mapped soil units, with over 50 units mapped in San Juan County by the NRCS, and each unit consisting of one to three soil types. Characteristics of all soil types, such as depth to restrictive layer, drainage class, permeability, depth to water table, and geologic parent material, are summarized in Table A-3 in Appendix A.

Hydrologic Soil Groups

Soils are classified by the NRCS into four Hydrologic Soil Groups (HSGs) based on soil runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Group A soils generally have the smallest runoff potential and Group D soils the greatest runoff potential. These ratings can also be generally equated to infiltration potential, with Group A soils having the greatest, and Group D soils, the lowest potential. Further descriptions of these soil groups are provided in Appendix A section *Soils*.

- **HSG Type A**: Group A soils typically have a high infiltration rate and consist mainly of deep, well drained to excessively drained sands or gravelly sands, and as such, have low runoff potential and a high rate of water transmission. In San Juan County, glacial outwash, eolian sands, and beach sands are classified as HSG Type A.

- **HSG Type B**: Group B soils typically have a moderate infiltration rate and depth, are fairly well drained, and have a fine texture to coarse texture. These soils have moderate runoff potential and a moderate rate of water transmission. Coarser-grained glacial drift and thin glacial outwash overlying drift typically fall into this category. Some peat deposits and drift mixed with colluvium derived from the weathering of bedrock are also classified as Group B but would not be considered as having a high infiltration potential.

- **HSG Type C**: Group C soils typically have a slow infiltration rate. These soils generally have moderately fine or fine textured restrictive layers that impede the downward movement of water. In storm events, there is moderately high runoff potential. These soils have a slow rate of water transmission, and typically consist of glacial drift over fine-grained deposits or mixed with soil that is the weathering byproduct of bedrock.

- **HSG Type D**: Group D soils typically have a very slow infiltration rate and consist of relatively thin, very fine-grained material that have a high water table and overlie nearly impervious material. These soils have a very slow rate of water transmission and have high runoff potential. In the San Juan Islands, this type consists of bedrock and glacial drift or fine-grained glaciomarine deposits mixed with soil that is the weathering byproduct of bedrock.

- **HSG Dual Type**: Group B/D and C/D soils are naturally Group D soils, primarily due to a high water table, or shallow depth to dense or fine-grained, non-infiltrative soils that may have characteristics of Group B or C soils if drained.

Erosion Potential

Soil erosion is a naturally occurring process the agents of which are water and wind. Soil erosion is a concern for maintaining stormwater quality as too much sediment (soil particles) in stormwater can adversely affect aquatic habitat by reducing light penetration and burying aquatic plants or spawning gravels. In addition, soil erosion can reduce the productivity of farmland, clog culverts and ditches, and damage property and roads. Moreover, pesticides and fertilizers are frequently transported along with eroding soil and can further contaminate or pollute downstream waters.

Erosion hazard areas include areas with soil that is likely to become unstable and are identified by slope and soil type primarily. Erosion factors for each soil type are noted within the NRCS Soil Survey as the surface erosion factor (Kw) (see Appendix A, Table A-3). The surface erosion factor indicates the susceptibility of a soil to erosion by water and is influenced by the soil's texture, structure, amount and type of organic matter, and permeability. Soils high in clay content often have low K values because they are resistant to detachment and therefore do not easily erode. Soils high in silt content are highly erodible and have high K values. Sandy soils, such as outwashes, allow water to infiltrate rather than run overland, and therefore have low K values (NRCS 2005). For soils in San Juan County, silty, steeply sloping, unconsolidated glacial drift deposits underlain at shallow depths by bedrock are the most susceptible to erosion hazard, and have the highest K value. Gently sloping, deep, and well-drained glacial outwash soils are least susceptible to erosion hazard.

Erosion is not solely determined by the soil type but also by environmental factors such as vegetation, topography, slope gradient and length, precipitation, groundwater conditions, land use, and development practices.

Groundwater and Aquifers

The islands have neither major rivers nor an annual snowpack. Thus, for the most part, our water supply comes from infiltration of precipitation that recharges aquifers on each of the islands. The amount of stormwater that infiltrates and recharges the aquifers is largely controlled by topography, land cover, and the hydrologic characteristics of the underlying soils and geology. The quality of drinking water supplies from aquifers can be reduced by stormwater that has not received adequate treatment prior to infiltration.

Groundwater

Groundwater is part of the continuous hydrologic cycle, which, in the natural state, begins with infiltration of precipitation and runoff (recharge) and ends with discharge to rivers, springs, streams, wetlands, and ultimately to seawater. Under natural conditions, groundwater recharge and discharge may shift with climatic cycle, but remain in overall balance. Withdrawal of groundwater by wells diverts a part of the groundwater cycle, resulting in adjustments to natural recharge, discharge, or both.

Recharge to groundwater occurs by direct infiltration of precipitation and infiltration of surface water runoff from higher elevations. Groundwater discharge occurs to creeks, springs, or ultimately to seawater along the margins of the islands. Generally, groundwater flows outward from the centers of each island toward the shorelines. Because of a high ratio of

shoreline length to land area in the County, there is an appreciable flow of groundwater to the sea (Orr et al. 2002). Domestic water supply wells remove groundwater from the aquifers and reduce the natural total discharge. This removal is typically not all consumptive, and a portion of removed water is returned to the aquifer as wastewater or treated wastewater.

Groundwater under saturated conditions flows preferentially through materials with greater porosity and permeability, such as clean gravels and sands or fractures in bedrock. Where geologic conditions limit discharge, groundwater accumulates in permeable zones, which, if they can support wells, are termed "aquifers." The sustainability of wells, or the long-term aquifer capacity, depends on the extent of the aquifer, its rate of recharge and natural discharge, and the withdrawal by producing wells.

Based on San Juan County regional hydrogeology described in reports by the US Geological Survey (Whiteman et al. 1983; Orr 2002) and Ecology (Russell 1975), groundwater in the San Juan Islands occurs within two primary geologic units: the Quaternary unconsolidated material (referred to as the glacial-deposit aquifer or glacial aquifer) and the bedrock or consolidated material of an older age (referred to as the bedrock aquifer).

Glacial Aquifers

Glacial aquifers occur in glacial sediments overlying bedrock units. The glacial deposits vary in extent and thickness and, where saturated and permeable, can yield large quantities of water to wells. The geographic distribution of the glacial aquifer varies between island and between drainage basins. As reported by Orr (2002), about 80 percent of the bedrock on Lopez Island is overlain by saturated glacial deposits with thicknesses of as much as 250 feet. However, less than 40 percent of San Juan Island is overlain by glacial deposits, and these are thin, discontinuous sheets with thicknesses less than 30 feet. Only about 15 percent of Orcas Island is overlain by isolated spots of glacial deposits that yield reasonable amounts of water. For Shaw Island, Russel (1975) reports that less than 10 percent of the island's bedrock is overlain by glacial deposits.

Bedrock Aquifers

The bedrock in San Juan County is mostly nonporous, with water occurring primarily in joints and fractures called secondary porosity. The aquifer therefore yields only small quantities of water when compared to a saturated sediment aquifer. There are no direct groundwater migration pathways from the Washington mainland due to the geologic complexity of the region. Infiltration of groundwater through the overlying glacial aquifer and direct precipitation and infiltration onto bedrock in upland areas provide most groundwater recharge to the bedrock aquifer.

Critical Aquifer Recharge Areas

Critical Aquifer Recharge Areas, or CARAs, are defined by code as "areas with a critical recharging effect on aquifers used for potable water." These areas must be managed in a way that protects groundwater quality and ensures that sufficient recharge occurs to maintain groundwater levels. Though the primary focus is on protection of drinking water, CARAs must also be managed to protect groundwater flow to streams and wetlands that support fish and wildlife, particularly salmon. Critical aquifer recharge areas can also be identified as

being highly susceptible to contamination and can include the 5- and 10-year time of travel wellhead protection boundaries. They also typically incorporate water-bearing surface geology. A hydrologic analysis performed by San Juan County under state guidelines found that virtually all of San Juan County is moderately or highly susceptible to contamination (San Juan County 2008).

Water Users

Water supply wells fall into three general categories: Group A, Group B, or single-family domestic. Group A public water systems are those that serve 15 or more residential connections or 25 people/day. Group B systems serve less than 15 residential connections and less than 25 people/day. A single-family domestic well serves a single family and is not shared between households. All three categories of wells are present in San Juan County and water well information can be obtained from Ecology, and the state and local health departments. Most of the Ecology well reports are prepared by non-geologists and standardized geologic descriptions are not commonly utilized. Therefore, interpretations from the well reports are rough approximations and should only be used to obtain a general overview of regional geologic, soil, and groundwater conditions.

Groundwater use for drinking water supply was reviewed by the County as part of documents filed for Best Available Science during an update to the Critical Areas Ordinance. A document titled "San Juan County BAS Summary" dated September 2008 summarizes the use of groundwater for drinking water supply:

> *"Groundwater provides a significant portion of the drinking water in San Juan County. Though most of the designated growth areas in the County are served by surface water systems (Friday Harbor, Roche Harbor, Eastsound [54 percent surface water], Rosario Resort, Rosario Highlands, Olga, Doe Bay and Spring Point), the rural interior and shoreline areas are primarily served by private and community wells. A few water systems have had to install seawater treatment systems due to inadequate or poor quality groundwater."*

Land Use

Land use modifications associated with land development such as the removal of vegetation, replacement of previously pervious areas with impervious surfaces, and drainage channel modifications invariably result in changes to the characteristics of stormwater. Consequently, different land uses can alter significantly the hydrologic behavior of a watershed. The hydrologic changes that developed basins commonly exhibit are increased runoff peak flow, increased runoff volume, and reduced time to runoff peak flow (ASCE 1975). Land uses can also have a profound influence on the quality of stormwater runoff. These consequences are due to the introduction of pollutants of physical, chemical, and biological origin resulting from various land use activities. These contaminants can detrimentally affect aquatic organisms and alter the characteristics of the ecosystem. In summary, the deterioration of water quality, degradation of stream habitats, and increase in flooding are among the most tangible indicators of different land uses (Goonetilleke et al. 2005). These issues highlight the key role that land use planning and development standards can play in safeguarding our water resources.

Land use development standards that seek to maintain the natural hydrologic character of the site or region are most effective for protecting resources and property from stormwater impacts. The natural hydrology, or movement of water through a watershed, is shaped over centuries under location specific conditions to form a balanced and efficient system. When hardened surfaces such as roads, parking lots, and rooftops are constructed, the movement of water is altered; in particular, the amount of runoff increases and infiltration decreases. This results in increased peak flow rate and volume, and pollution levels in stormwater runoff. Land uses and standards designed with nature in mind, work with the natural landscape and hydrologic conditions to minimize these changes.

Land uses across the County are dominated by Residential at 37 percent of the County's land area, followed by Undeveloped Land and Water at 26 percent, and Resource Production and Extraction (essentially farming and forestry) at 24 percent. Aggregated existing land uses in San Juan County are provided in Table 1. More detailed discussion of land uses for each watershed are provided in the *Watershed Resources* section of this report. Methods used for determining existing land uses are provided in Appendix B.

Table 1. Summary of Land Uses in San Juan County.

Land Use Category	Total Acres	Percent of County
Cultural, Entertainment, and Recreational	9,662	9%
Manufacturing	46	0%
Residential	39,839	37%
Resource Production and Extraction	25,241	24%
Services	3,425	3%
Transportation, Communication, and Utilities	869	1%
Undeveloped Land and Water Areas	27,632	26%
Wholesale or Retail Trade	116	<1%
Grand Total	106,832	100%

Impervious Cover

Impervious cover is any surface in the landscape that cannot effectively absorb or infiltrate rainfall. This includes driveways, roads, parking lots, rooftops, and sidewalks. When natural landscapes are intact, rainfall is absorbed into the soil and vegetation. These mediums naturally slow down, spread out, and soak up precipitation and runoff. Water percolating into the soil becomes a stable supply of groundwater, and the runoff is naturally filtered of impurities before it reaches creeks, streams, rivers, and bays.

As areas become more developed, the amount of impervious cover increases removing these natural filter systems that previously intercepted runoff. This has serious implications for water quality and flood control. A growing body of scientific literature has shown that groundwater recharge, stream base flow, and water quality measurably change and can decrease as impervious cover increases (CWP 2003). Research generally indicates that stream quality varies based on watershed impervious cover. Most notably, at between 5 and 10 percent impervious cover, sensitive stream elements are lost from the system and include

diminished aquatic diversity and water quality (CWP 2003; May et al. 1997). Studies have confirmed there is a direct relationship between the intensity of development, as indicated by the amount of impervious surface, and the degree of damage in a watershed (CWP 2003; May et al. 1997).

Impervious cover among County watersheds is relatively low overall. The highest percent of impervious area in a watershed is found within the North Shore of Orcas (which includes most of Eastsound) at 10.2 percent, followed by Friday Harbor at 9.5 percent, and Roche Harbor at 9 percent. Virtually all other watersheds have less than 5 percent impervious area. Table 2 provides the existing impervious cover found within each watershed in alphabetical order as determined using methods by Fry et al. (2011). Impervious cover at buildout was estimated in order to identify those watersheds at greatest risk from potential future development. The buildout impervious area estimates provided in Table 2 are gross estimates that do not take into account setbacks, critical areas, buffers, and small waterbodies. Figure 6 illustrates categorical percent increase from existing to buildout and also indicates the gross estimate at buildout shown in Table 2. Actual impervious area at buildout would likely be somewhat less than estimated here. Nevertheless, the estimate provides a relative measure that suggests which watersheds have the greatest risk from future stormwater problems.

Future buildout estimates indicate that Friday Harbor and the North Shore of Orcas will continue to have the highest percentages of impervious area. Other currently low and more rural watersheds such as Griffin Bay and Westcott Bay on San Juan, and Raccoon Point and West Sound on Orcas will become increasingly impervious predominantly from residential development. All County watersheds will exceed the lowest 5 percent threshold documented as an indicator of stream degradation and approximately half will exceed the higher threshold of 10 percent impervious. Methods used to determine impervious area are located in Appendix B.

Infiltration Assessment

Stormwater infiltration is a commonly used management tool to reduced associated impacts on surface water. A preliminary assessment of the suitability of particular areas in San Juan County for infiltration of stormwater indicates a number of areas where infiltration may be feasible. Key factors for this assessment include the surficial geology and soils characteristics of the basin. The overlap of these two data groups indicate the areas most likely to allow infiltration of excess stormwater.

Surficial Geology

Coarse-grained geologic units derived from glacial sediments, such as a sand and gravel outwash or coarse-grained drift deposit, are the most likely receptors for the infiltration of stormwater. Figure 7 displays selected mapped surficial geology units typically associated with coarse-grained soils grouped as follows: Sumas and Vashon Recessional deposits, sandy (including Qgds, Qvrc, Qvrm, Qgog, Qgomem, Qvrme, and Qvrmo) and Vashon advance outwash (Qva or Qga). Additional units mapped in the area shown on Figure 7 include recent deposits (Qd, Qb, Qtf, Qm, Qa, and Qp), landslides, bedrock and fine-grained glacial drift deposits (Qvt, Qgt, Qgdmes, Qgdme, Qvrms, and Qvrmd); neither of which allow substantial

Table 2. Sum and Percent of Impervious Cover by Watershed.				
Watershed	Acres of Existing Impervious (2011)	Percentage of Existing Impervious (2011)	Estimated Acres of Impervious at Full Build-Out	Estimated Percentage of Impervious at Full Build-Out
Aleck Bay	4.9	2.1%	28.9	12.4%
Davis Bay	102.7	2.0%	599.7	11.9%
Deer Harbor	59.1	3.4%	199.1	11.6%
Doe Bay	55.4	1.5%	269.4	7.4%
Eastsound	339.4	2.4%	1095.4	7.8%
False Bay	170.6	1.5%	1217.6	10.5%
Fisherman Bay	82.2	5.4%	169.2	11.1%
Fisherman Bay Peninsula	2.1	2.1%	6.1	6.2%
Friday Harbor	356.5	9.8%	661.5	18.2%
Garrison Bay	20.6	1.1%	162.6	8.7%
Griffin Bay	301.7	7.6%	570.7	14.4%
Guthrie and Grindstone Coves	57.2	1.7%	375.2	11.4%
Haro Strait	60.5	1.8%	300.5	8.8%
Hughes Bay	16.9	1.7%	87.9	8.9%
Hunter Bay	15.8	1.2%	148.8	11.7%
Iceberg Point	3.0	1.4%	24.0	11.4%
Juan de Fuca Strait	79.6	4.5%	182.6	10.2%
Lopez Sound	25.6	1.1%	156.6	6.7%
Mackaye Harbor	32.8	3.3%	97.8	9.7%
Mitchell Bay	21.3	3.8%	53.3	9.6%
Mud Bay	20.9	1.8%	106.9	9.1%
North Shore	127.5	10.4%	215.5	17.6%
Outer Bay	3.3	2.2%	13.3	8.9%
Presidents Channel	46.9	1.6%	301.9	10.6%
Raccoon Point	54.7	1.7%	183.7	5.8%
Roche Harbor	26.2	9.2%	46.2	16.2%
San Juan Channel (Lopez)	30.2	6.6%	47.2	10.3%
San Juan Channel (San Juan)	89.7	1.6%	512.7	9.1%
Shaw Island	81.3	1.7%	451.3	9.2%
Shoal Bay	23.0	4.3%	54.0	10.2%
Spieden Channel	33.7	4.5%	82.7	11.1%
Swift Bay	37.0	2.1%	155.0	8.6%
Upright Channel	33.4	2.8%	84.4	7.2%
Watmough Bay	8.1	0.9%	73.1	8.0%
West Sound	153.5	2.2%	821.5	12.0%
Westcott Bay	60.2	3.2%	290.2	15.5%

Note: Outer Islands were not included in this calculation.

infiltration. Undifferentiated glacial drift deposits (Qgd, Qguc, Qu) which may include areas that are conducive to infiltration are also shown.

Soil Characteristics

The properties of the underlying geologic unit control a soil's hydrologic and therefore infiltrative properties. Group A soils and Group B soils with "flat to gently sloping" topography are the most likely to provide long-term infiltration opportunities. Besides the soil, the thickness of the permeable soil and depth to fine-grained, non-infiltrative surface will determine infiltration potential and infiltration facility design recommendations in these locations. Group C and D soils are typically not considered suitable for shallow infiltration. Figure 8 displays the hydrologic soil group (HSG) soil data. With some exceptions, Group A and A/D soils are mapped as "A- High Infiltration Rates", Group B and B/D soils mapped as "Moderate Infiltration Rates", Group C and C/D soils as "Low Infiltration Rates", and Group D soils as "Very Slow Infiltration Rates". Two additional categories are shown: soils with low infiltration feasibility, such as peat, rock, and soil in tidal areas are mapped as "Infiltration Not Feasible" regardless of the HSG grouping. Soils with slopes greater than about 20 percent are typically not recommended for surficial infiltration due to increased slope failure potential from the increased hydraulic loading that comes with infiltration. These soil units are mapped as "Infiltration Not Feasible – Steep Slopes".

Selected Infiltration Areas in San Juan County

GIS was used to create an overlay of selected surficial geology units and soils data with high to moderate infiltration potential to identify areas that may be most conducive to infiltration. Figure 9 displays the results of this overlay. There are a few areas, discussed in more detail below, within San Juan County where the selected geologic units overlap with soils in Group A and B.

There may be other areas in the County where infiltration could be feasible. There are numerous locations on the island covered by Group A and B soils (high to moderate infiltration rates) that do not overlap with the areas mapped geologically as some outwash. This could be caused by the classification of some Group B soils as glacial drift deposits. Though fine-grained drift deposits are not as permeable as outwash, isolated areas of coarse-grained drift could prove receptive to infiltration, and long-term infiltration into these soils could be feasible depending on slope, water table depth, and depth to restrictive feature. The coarseness of the 1:100,000 maps that cover most of the islands does not distinguish isolated, or small areas of coarse-grained soils within spatially larger, fine-grained units. Thus, some of the Group B soils are mapped as drift, and other outwash areas may not be shown on the existing geologic maps. In-depth records research and field explorations would be required to evaluate soil, geologic, and groundwater properties in any potential infiltration area prior to design. As such, the overlay of the NRCS soils data and the surficial geology likely provides the best regional-scale information available to identify the areas of the county with the greatest infiltration potential.

Areas Vulnerable to Stormwater Infiltration

In San Juan County, areas most vulnerable to impacts from stormwater infiltration include steep slopes and critical aquifer recharge areas. Steeply-sloping permeable soil units underlain by less permeable soil units at shallow depth present landslide risks where present throughout Puget Sound. During heavy precipitation events, this soil configuration could lead to saturation of the upper, permeable soil layer and result in stormwater overland flow. Care should be taken to identify and avoid infiltration of stormwater into these areas. Infiltration systems must be set back at least 100 feet from the edge of a slope when the slope is greater than 10 percent, and should be avoided on slopes greater than 20 percent (Ecology 2012).

Both domestic and community water supply wells are located in San Juan County. When siting stormwater facilities, a 100-foot sanitary control radius around the wellheads must be maintained. When siting stormwater facilities, setbacks from septic drainfields must also be considered. For infiltration facilities, there is a minimum 100-foot setback from regional treatment (i.e., centralized, common facilities) (Ecology 2012). For onsite residential septic systems, infiltration or bioretention facilities should not be placed immediately upstream to avoid saturating the septic field and should be placed at least 10 feet downstream or sufficient distance to ensure that septic effluent is fully treated before reaching the infiltration/ bioretention zone. The objective is to ensure that any overflow from the bioretention cell is not contaminated with effluent from the onsite septic system (San Juan County Health Department 2011).

Water Quality

A number of water quality monitoring programs have been undertaken by San Juan local and regional entities in recent decades. While not fully inclusive, data from these programs provide background information on several of the major pollutants found in stormwater or urban runoff (i.e., sediment, nutrients, trace metals, petroleum hydrocarbons, bacteria, and organic chemicals). The following readily available information sources were reviewed to evaluate major trends in water quality in the San Juan County watersheds.

- **2012 303(d) Listing Status**: As described above in the *Regulatory Drivers* section, Ecology assesses the water quality status for a particular location in one of five categories of water quality health. The assessment is presented in the Section 303(d) list of impaired waterbodies.

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: Established in 2001 as a partnership between the University of Washington Friday Harbor Laboratories, San Juan Island School District, and Spring Street International School. From 2002 to 2008, FHLSOP collected baseline water quality data in 12 major watersheds on San Juan, Lopez, and Orcas Islands every 6 to 8 weeks. *In situ* parameters included water temperature, dissolved oxygen, pH, turbidity, and flow, with nutrients (nitrates, ortho-phosphates) and fecal coliform analyzed at Friday Harbor Labs (data accessed March 2014: http://depts.washington.edu/fhlk12/monitor /sanjuan/sanjuan.html).

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – Friday Harbor Marina Water Quality Monitoring Project**: Monitors collect samples at six sites in the Friday Harbor marina five times each year for water temperature, salinity, current direction, and fecal coliform. Monitoring data are available for the period 2002 to 2013.

- **San Juan County Pilot Stormwater Monitoring Program**: Six focus areas (i.e., Fisherman Bay, Mud Bay, False Bay, Garrison Bay, Westcott Bay, and East Sound) are included in an ongoing three-year pilot-level assessment of stormwater quality in San Juan County. Year 1 stormwater quality data were collected during three storm events between November 2012 and April 2013 (November 12, 2012, January 23, 2013, and April 5, 2013). *In situ* parameters included water temperature, dissolved oxygen, pH, specific conductivity, and turbidity. Analytical constituents included coliform, nutrients (nitrate + nitrite nitrogen , ammonium nitrogen, organic nitrogen, total nitrogen; ortho-phosphorus; total phosphorus), metals (arsenic, cadmium, copper lead, zinc), total petroleum hydrocarbons [TPHs] (benzene, toluene, ethyl-benzene, total xylenes, and gasoline (C8-C12)), pesticides/herbicides (permethrin, MGK-264, glyphosate), and anionic surfactants (Stillwater Sciences 2014). Year 2 of the monitoring program is currently underway.

- **Washington State Department of Health (DOH) Receiving Water Coliform Monitoring**: Coliform data are collected on a bimonthly basis from nine bays or channels throughout San Juan County.

In addition, the following information sources were used to provide context for San Juan County stormwater quality data:

- **Puget Sound Phase 3 Monitoring**: Beginning in 2006, Ecology has been conducting studies to quantify the amount and to identify the primary sources of toxic chemicals in the Puget Sound ecosystem. Phase 1 and Phase 2 studies relied on existing data from literature sources to provide surface runoff loading estimates. The Phase 3 study improves upon the Phase 1 and 2 loading estimates and advances understanding of the timing and sources of contaminant loading in the Puget Sound ecosystem by collecting and analyzing new local data (Ecology and King County 2011).

- **National Urban Runoff Program (NURP)**: Between 1978 and 1983, USEPA examined stormwater quality from separate storm sewers and different land uses. The NURP project studied 81 outfalls in 28 communities throughout the US and included the monitoring of approximately 2,300 storm events (USEPA 1983). In 1999, an analysis of stormwater data collected since the original NURP study was conducted to update the event-mean concentration (EMC) values for typical urban stormwater quality (Smullen et al. 1999). A summary of the 1983 (NURP) and 1999 databases is presented in Smullen et al. (1999) and Shaver et al. (2007).

Review of water quality data for San Juan County suggests that water quality is supportive of Ecology designated beneficial uses regarding water temperature, dissolved oxygen, pH, and turbidity. Exceptions include five locations, which are included on the Ecology 2012 303(d) list as “waters of concern” (Category 2) or “impaired” waterbodies (Category 5) with respect

to these parameters (Figure 10) (see more detailed descriptions in the *Watershed Resources* section):

- **False Bay watershed, unnamed creek (Tributary to San Juan Valley Creek) just upstream of Bailer Hill Road**: Water of concern regarding dissolved oxygen
- **Friday Harbor (San Juan Channel)**: Impaired regarding dissolved oxygen
- **East Sound**: Impaired regarding dissolved oxygen
- **East Sound watershed, unnamed creek (Tributary to East Bay/Buck Bay)**: Water of concern regarding dissolved oxygen
- **East Sound**: Water of concern regarding pH

Several common stormwater constituents have been found at low levels or are non-detectable, including total and dissolved metals (arsenic, cadmium, lead, zinc), TPHs, and three herbicides/pesticides commonly used on the islands (permethrin, MGK-264, and glyphosate). Total copper may be somewhat elevated at particular sites, but overall, is generally similar to recently reported median values for Puget Sound Phase 3 monitoring (Ecology and King County 2011). Based on San Juan County Pilot Stormwater Monitoring Program 2012–2013 data, all dissolved metals are below Ecology acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in San Juan County stormwater with respect to metals. Anionic surfactants are far below USEPA criteria for drinking water sources. Nutrient concentrations are low to moderate compared with values measured in Puget Sound Phase 3 monitoring and reported in three national databases of monitored stormwater concentrations (Stillwater 2014).

In contrast to other stormwater constituents, bacteria (i.e., fecal coliform, *Escherichia coli*) are generally elevated in stormwater in San Juan County. Friday Harbor is included the Ecology's 303(d) list as a "water of concern" (Category 2) and the following five locations are included on the 303(d) list as "impaired" waterbodies (Category 5) with respect to bacteria (Figure 10) (see more detailed description in *Water Resources* section):

- False Bay watershed, San Juan Valley Creek, from the intersection with Timber Lane downstream to False Bay
- False Bay watershed, unnamed creek (tributary to San Juan Valley Creek) just upstream of Bailer Hill Road
- False Bay watershed, unnamed Creek (tributary to Trout Lake)
- East Sound watershed, unnamed creek (tributary to East Bay/Buck Bay)
- Lopez Sound watershed, unnamed creek (tributary to Lopez Sound)

A preliminary analysis of San Juan County Pilot Stormwater Monitoring Program 2012–2013 data indicates that Garrison Bay, False Bay, and Westcott Bay focus areas exhibit relatively lower bacteria and nutrient concentrations, while Mud Bay, Fisherman Bay, and East Sound focus areas exhibit relatively higher concentrations (Tables 3 and 4). Additional data

collected during Years 2 and 3 of the pilot monitoring program should allow for more a definitive comparison between focus areas and may allow for identification of specific sources of nutrients and/or pathogens within the five priority basins. Further, monitoring of receiving waters and receiving water sediments during Years 2 and 3 of the pilot program will help to determine whether stormwater constituents are present at levels sufficient to affect water and sediment quality in the bays and channels that surround the islands.

Table 3. San Juan County Pilot Stormwater Monitoring Program Year 1 (2012–2013) Nutrient Species by Watershed.

Nutrient Species	Garrison Bay	False Bay	Westcott Bay	Mud Bay	Fisherman Bay	East Sound	p [a]
Nitrate + nitrite nitrogen (mg/L)	0.19 ± 0.17 (n=3)	0.06 ± 0.04 (n=6)	0.12 ± 0.14 (n=11)	0.07 ± 0.03 (n=2)	0.34 ± 0.35 (n=18)	0.45 ± 0.45 (n=13)	0.06
Ammonium nitrogen (mg/L)	0.07 ± 0.03 (n=3)	0.13 ± 0.04 (n=6)	0.12 ± 0.04 (n=6)	0.19 ± 0.04 (n=2)	0.19 ± 0.11 (n=12)	0.14 ± 0.11 (n=13)	0.14
Organic nitrogen (mg/L)	0.38 ± 0.19 (n=3)	0.79 ± 0.17 (n=6)	0.66 ± 0.14 (n=11)	1.5 ± 0.2 (n=2)	0.93 ± 0.48 (n=18)	0.56 ± 0.49 (n=13)	0.01
Total nitrogen (mg/L)	0.63 ± 0.12 (n=3)	0.98 ± 0.17 (n=6)	0.90 ± 0.24 (n=11)	1.7 ± 0.2 (n=2)	1.5 ± 0.2 (n=18)	1.2 ± 0.7 (n=13)	0.01
Ortho-phosphorus (ug/L)	15 ± 7 (n=2)	36 ± 13 (n=6)	23 ± 8 (n=11)	20 (n=2)	62 ± 30 (n=12)	82 ± 84 (n=9) [b]	0.02
Total phosphorus (ug/L)	22 ± 25 (n=2)	65 ± 21 (n=6)	57 ± 18 (n=11)	93 ± 16 (n=2)	134 ± 84 (n=18)	88 ± 105 (n=12) [b]	0.06

Values shown are the multi-storm event mean ± 1standard deviation, with sample size in parentheses.

[a] Single factor analysis of variance (ANOVA) *p* statistic. Values less 0.05 indicate there are significant differences in between watersheds for the associated parameter.

[b] Excluding assumed outliers at Site O-E4 on November 12, 2012 (ortho-phosphorus = 980 ug/L; total phosphorus = 1,100 ug/L).

Source: Stillwater Sciences (2014).

Table 4. San Juan County Pilot Stormwater Monitoring Program Year 1 (2012–2013) Bacteria Results by Watershed.

Site	Garrison Bay	False Bay	Westcott Bay	Mud Bay	Fisherman Bay	East Sound	p [a]
Fecal coliform	7 ± 2 (n=3)	82 ± 3 (n=5)	14 ± 8 (n=6)	120 ± 5 (n=2)	40 ± 5 (n=12)	80 ± 4 (n=13)	0.09
E. coli	5 ± 3 (n=3)	45 ± 2 (n=5)	7 ± 8 (n=6)	46 ± 3 (n=2)	21 ± 4 (n=12)	101 ± 7 (n=13)	0.02

Values shown are the multi-storm event geometric mean ± 1standard deviation, with sample size in parentheses.

[a] Single factor analysis of variance (ANOVA) *p* statistic using geometric mean values.

Source: Stillwater Sciences (2014).

Reported Stormwater Problems

San Juan County prepared a web-based site for citizens to report stormwater management problems called the Stormwater Basin Planning Web Map found at

http://sjcgis.maps.arcgis.com/home/item.html?id=cd645b044c5445e3a3799ce94e1d0524. A completed listing of the reports received is provided in Appendix C organized by watershed. Table C-1 in Appendix C provides the location, type of problem and a brief description of each.

As of this report, 127 problems were entered into the database. Of these, the vast majority were in the watersheds with urban growth areas. The East Sound watershed had the highest number of stormwater problems with 33 percent of the total reported followed by Friday Harbor with 10 percent. The North Shore of Orcas watershed followed next with 8 percent. The village of Eastsound encompasses portions of both the East Sound and North Shore of Orcas watersheds and accounts for the location of close to 41 percent of all stormwater complaints.

Over 70 percent of the problems reported directly related to high stormwater flows and included reports of flooding, erosion, and ponding. Four percent of the complaints related to observed water quality problems. Thirteen percent of the complaints classified their complaint as damage to property; the majority of these were on private property. Stormwater problems resulting from private development is a significant concern is some areas of the County such as the Rosario neighborhood on Orcas. The County is concerned over how to solve stormwater problems that are the result of private development not constructed to common or regulatory standards. There are legal and political barriers to addressing these problems with public funds.

Another countywide stormwater issue reported anecdotally is a concern about the proliferation of ponds across the County and their potential effects on aquifer capacity and recharge from surface water evaporation. Significant evaporation can occur because of the water surface area exposed to the atmosphere from ponds during the summer season. Ponds also are suspected of disrupting natural flow patterns on the islands to the detriment of streams and historical fisheries. The cumulative effect of ponds along a stream can trap and store large amounts of water, delaying instream flow and hindering stream access to any returning fish. Each time a pond is constructed without a bypass, and has unfilled storage in the fall months, the season for viable instream flows to support salmonid species is shortened. In addition, since the water in ponds can comprise a great deal of unshaded surface area, the first several feet of water in a pond or lake may be heated while the bottom remains cool. Unfortunately, the superheated water from the surface is often what is discharged back into the stream thereby lowering dissolved oxygen levels within the creek system with further adverse effects on aquatic organisms.

WATERSHED RESOURCES

In 2010, the San Juan County Citizens Stormwater Advisory Committee requested that Public Works provide basic watershed delineations that could be used for planning. This was accomplished using ESRI's ArcHydro tool to generate 37 watersheds from the 2009 LiDAR data. These watersheds were further refined by hand to delineate the breaks along ridgelines and group the many of the small watersheds into larger ones. The exceptions to this method include Shaw Island, which is included as one watershed, and the outer populated islands including Blakely, Brown, Canoe, Center, Crane, Decatur, Henry, Obstruction, Stuart, and Waldron islands, which were all combined into one planning area. This report section details land uses, describes existing stormwater infrastructure, identifies important natural resources, and provides known water quality information for each watersheds.

San Juan Island

False Bay

Land Use

The existing land use in False Bay is mostly a mix of agriculture and single-family residential with some undeveloped lands over 5 acres in size (see Table 5).

Table 5. Existing Land Use in False Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	64	1%
Manufacturing	0	0%
Residential	4,058	35%
Resource production and extraction	4,144	36%
Services	648	6%
Transportation, communication and utilities	42	0%
Undeveloped land and water areas	2,509	22%
Wholesale or retail trade	1	0%
Total	**11,464**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 11,464 acres in size and is in the south central portion of San Juan Island, and is the largest basin on the Island. The watershed generally flows to the south into False Bay, and consists of three main drainage basins with defined outlets into the receiving water; see Figure 11. There is a total elevation drop of about 850 feet across the

watershed starting from the top of Cady Mountain. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Beaverton Valley Road, Boyce Road, Wold Road, San Juan Valley Road, and Bailer Hill Road.

Wold Road - Basin 1 of the watershed is approximately 1,200 acres in size and is located in the southern portion of the watershed; see Figure 12. There is a total elevation drop of about 850 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 2 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and lake areas NW of Wold Road and crosses Wold Road with a 36-inch culvert, and then crosses Bailer Hill Road with a 36-inch culvert. Flow then continues SE about 1.3 miles to False Bay across a very gentle valley with wetlands, crossing Kanaka Bay Road with two 36-inch culverts about 1,000 feet before entering the Bay.

San Juan Valley - Basin 2 of the watershed is approximately 10,000 acres in size and is located in the central portion of the watershed; see Figure 13. There is a total elevation drop of about 850 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and lake areas north of West Valley and Beaverton Valley roads and crosses West Valley Road with a 24-inch culvert near the Lawson Farm and Beaverton Valley Road in three places with 24-inch, 24-inch, and 24-inch culvert at Lake Edna. A 12-inch and 18-inch culvert also cross Beaverton Valley Road as flows all continue to the south. Flows then combine and continue west about 4,000 feet to cross Boyce Road with a 48-inch culvert. Continuing south and combining with flows from Margos Lake, a 120-inch culvert crosses Wold Road. This flow combines with flows from the north into Zylstra Lake and continues south where it combines with flow from the 36-inch culvert that crosses San Juan Valley Road, and finally crosses Bailer Hill Road with a 144-inch arched culvert about 4000 feet before entering False Bay.

Frog Song Trail - Basin 3 of the watershed is approximately 100 acres in size and is located in the SW bottom portion of the watershed; see Figure 14. There is a total elevation drop of about 300 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas east of False Bay Drive near Frog Song Trail private Road and crosses False Bay Drive with a 24-inch culvert and then continues west about 200 feet before entering the Bay

Critical Resources

Aquatic resources in the watershed are summarized in Table 6.

Nearshore and Marine

The marine shoreline in this watershed is False Bay.

Table 6. Summary of Aquatic Resources in False Bay Watershed.	
Freshwater Wetlands	1,123 acres (10%)
Tidal Wetlands	0 acres (0%)
Streams	35.9 miles (3.6 miles fish-bearing)
Significant Lakes	Trout Lake (54 acres) Woods Lake (29 acres) Zylstra Lake (48 acres)
Aquifer Recharge Areas	403 acres (3%)

Note: Significant lakes are greater than 20 acres.

Wetland, Aquatic, and Riparian

A patchy distribution of wetlands is present throughout the watershed, encompassing 1,123 acres (10 percent) of the watershed. Significant aquifer recharge areas are present near Bailer-Hill Road, and north of West Valley Road between Boyce Road and Egg Lake Road.

Threatened, Endangered, and Species of Local Concern

False Bay contains sensitive habitat for shellfish including Dungeness crab. Eelgrass beds are present near the entrance of False Bay and pocket estuaries may provide habitat areas for forage fish, bald eagles, and other sensitive species. False Bay Creek supports priority coho salmon.

Basin Water Quality Evaluation

Non-point source runoff in the False Bay watershed has been a water quality concern for a number of years. The San Juan County Watershed Management Action Plan, developed between 1997 and 1999, listed polluted stormwater runoff as a "high priority risk" for False Bay, along with Friday Harbor and East Sound (San Juan County 1999).

The following information sources were reviewed to evaluate major trends in water quality in the False Bay watershed:

- **303(d) Listing Status**
- **Friday Harbor Labs Science Outreach Program (FHLSOP) - San Juan Islands Watershed Project**: – False Bay sites included:
    - Site FB1 – stream 0.5-mile downstream of Trout Lake at Julie Road
    - Site FB2 – Nettles Creek, a tributary that runs into False Bay Creek, at Club Mud Road
    - Site FB3 – False Bay Creek at Valley Farm Road
    - Site FB6 – lower reach of San Juan Valley Creek, at north end of False Bay Preserve
- **San Juan County Pilot Stormwater Monitoring Program:**

- Year 1 data are available for the following sites in the False Bay watershed:
  - Site SJ-F1 – lower reach of San Juan Valley Creek, upstream of Bailer Hill Road crossing at the Land Bank
  - Site SJ-F3 – lower reach of San Juan Valley Creek, at north end of False Bay Preserve
- During Year 2 of the pilot monitoring effort, the following additional sites are being sampled:
  - Site SJ-F2 – at the Kanaka Bay Road culvert outfall on south side of road)
  - Site SJ-F4-M – receiving water/sediment site in False Bay

In situ Parameters

Results from the 2002–2008 FHLSOP and the 2012-2013 SJC pilot stormwater monitoring effort showed water temperature and pH levels in the False Bay watershed generally supportive of all Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Dissolved oxygen tends to be greater than 8 mg/L at upstream sites, but can decrease below 7 mg/L in downstream reaches of San Juan Valley Creek. The Unnamed Creek (tributary to San Juan Valley Creek) just upstream of Bailer Hill Road is included on the 303(d) list as a water of concern (Category 2) with respect to dissolved oxygen (Listing 12764) (Figure 10). For Category 2 waters, there is some evidence of low dissolved oxygen, but not enough for Ecology to require a water quality improvement project at this time. Additional data are needed to characterize current conditions for dissolved oxygen in the False Bay watershed, particularly in San Juan Valley Creek, as much of the 2012-2013 dissolved oxygen data were flagged for quality assurance review issues (Stillwater Sciences 2014).

Based on 2012-2013 data, turbidity in San Juan Valley Creek is variable but is generally below 20 NTU.

Bacteria

Three stream reaches are included on the 303(d) list as a Category 5 waterbodies impaired for bacteria (Figure 10):

- San Juan Valley Creek, from the intersection with Timber Lane downstream to False Bay (Listing 45246; http://apps.ecy.wa.gov/wats/)
- Unnamed creek (tributary to San Juan Valley Creek) just upstream of Bailer Hill Road (Listing 45712)
- Unnamed Creek (tributary to Trout Lake) (Listing 45627)

These listings are based on the freshwater primary contact recreation designated beneficial use, which has a fecal coliform criterion of <100 CFU/100 mL (geometric mean), and with ≤10 percent of all samples >200 CFU/100 mL (WAC-173-201A-200). Category 5 waterbodies require development and implementation of the TMDL.

Bacteria data collected during the 2002–2008 FHLSOP and 2012–2013 pilot stormwater monitoring effort indicated that fecal coliform levels have varied but have generally met the criteria for the primary contact recreation beneficial use. The exceptions were in 2004 and 2005, when samples at Site FB6 exceeded the criteria. During 2012–2013, fecal coliform counts ranged 33–320 CFU/100 mL, with a geometric mean of 82±3 and a single sample >200.

When compared across all six pilot study focus areas, False Bay is among those focus areas (along with East sound and Mud Bay) that exhibited relatively higher fecal coliform and *E. coli* levels in 2012–2013 (Table 4). Additional data collected during years 2 and 3 should allow for more a definitive comparison between focus areas and may allow for identification of specific sources of nutrients and/or pathogens within the six focus areas.

Nutrients

Results from the 2002-2008 FHLSOP indicated that nitrate and ortho-phosphorus concentrations have varied on San Juan Island and have not consistently met guidelines adopted by the San Juan Islands Conservation District (SJICD) (i.e., nitrate ≤1 mg/L and ortho-phosphorus ≤0.1 mg/L). During the 2012-2013 SJC pilot stormwater monitoring effort, nutrient concentrations at False Bay sites were low to moderate (nitrate + nitrite nitrogen 0.01–0.1 mg/L; ammonium nitrogen 0.08–0.2 mg/L; organic nitrogen 0.6–1.1 mg/L; total nitrogen 0.80–1.3 mg/L; ortho-phosphorus 0.2–0.4 mg/L; total phosphorus 0.4–0.9 mg/L) compared with values measured in the other five San Juan County focus areas (Table 3), as well as with values measured in Puget Sound Phase 3 monitoring (Ecology and King County 2011) and three national databases of monitored stormwater concentrations (Stillwater Sciences 2014).

Metals

During the 2012-2013 SJC pilot stormwater monitoring effort, total metals were relatively low at False Bay pilot stormwater monitoring sites (arsenic ≤ 1.0 ug/L; cadmium <1.0 ug/L; copper <2–3.2 ug/L; lead <0.5 ug/L; zinc <2.5–15 ug/L) compared with reported values for typical urban stormwater runoff and Puget Sound Puget Sound Phase 3 monitoring (Ecology and King County 2011). All dissolved metals were below available Ecology hardness-based acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in False Bay stormwater with respect to metals. Since hardness was only collected during the April 5, 2013 storm event, however, additional data are needed to confirm this conclusion (Stillwater Sciences 2014).

TPHs and Herbicides/Pesticides

Measured concentrations of TPHs (benzene, toluene, ethyl-benzene, total xylenes, and gasoline [C8-C12]) were below the analytical detection limits (0.4–100 ug/L) during 2012-2013 San Juan County pilot stormwater monitoring. Herbicides/pesticides commonly used in San Juan County, including permethrin, MGK-264, and glyphosate, were below the analytical detection limits (0.1–10 ug/L) at False Bay pilot monitoring sites during 2012-2013.

Surfactants

Anionic surfactants measured at False Bay sites during the 2012-2013 SJC pilot stormwater monitoring effort (0.1–1.5 ug/L) were similar to previous measurements reported for multiple

sites across the San Juan Islands (i.e., range = 0.17–1.3 ug/L, mean = 0.57 ug/L; Barsh et al. 2008) and are far below the available USEPA criterion[1] for drinking water sources (500 ug/L).

Risk Summary and Management Recommendations

The False Bay watershed is the second largest in the County and has one of the lowest existing percent impervious cover (1.5 percent). The watershed has a relatively high percent of freshwater wetland area (10 percent) as well as the most stream miles of any watershed (just under 36) of which 3.6 miles are documented to be fish bearing; a fairly rare occurrence in San Juan County. There are three large lakes in the watershed and significant nearshore aquatic resources. Problems in the basin include some minor flooding but are mostly dominated by water quality concerns specifically related to elevated fecal coliform bacteria and low dissolved oxygen, particularly in lower stream reaches. Agriculture and residential housing are expected to continue to dominate land use in this watershed. Given that impervious cover is estimated to increase to 10.5 percent under full buildout conditions (Table 2), it is reasonable to assume these problems will continue and likely increase in severity. Therefore, we recommend that this watershed be considered a high priority for stormwater improvements and particularly focused on water quality treatment solutions. In addition, the CSWAC prioritized this watershed for further study in connection with Volume 2 of this report to identify appropriate stormwater management strategies.

Friday Harbor

Land Use

The existing land use in the Friday Harbor watershed is a mix of single-family residential, undeveloped lands over 5 acres in size, agriculture, educational services, undeveloped residential lands less than 5 acres in size, and designated forest land (see Table 7).

Table 7. Existing Land Use in Friday Harbor.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	20	1%
Manufacturing	4	0%
Residential	1,533	44%
Resource production and extraction	523	15%
Services	367	10%
Transportation, communication and utilities	16	0%
Undeveloped land and water areas	1,009	29%
Wholesale or retail trade	22	1%
Total	**3,495**	**100%**

Source: San Juan County (2013)

[1] USEPA secondary standards are non-enforceable guidelines regulating contaminants that may impact cosmetic (e.g., skin or tooth discoloration) or aesthetic (e.g., taste, odor, or color) qualities of drinking water. The State of Washington currently does not enforce secondary drinking water standards.

Stormwater Infrastructure

The watershed is approximately 3,495 acres in size and is in the east central portion of San Juan Island. The watershed generally flows to the east into Friday Harbor, and consists of three main drainage basins with defined outlets into the receiving water; see Figure 15. There is a total elevation drop of about 400 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Halvorsen Road, Roche Harbor Road, and Turn Point Road.

Beaverton Valley - Basin 1 of the watershed is approximately 2,500 acres in size and is located in the northern portion of the watershed; see Figure 16. There is a total elevation drop of about 400 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 2 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetlands and lake areas NW of Halvorsen Road and crosses Halvorsen Road with a 12-inch and 18-inch culvert and then continues flowing east and crosses Roche Harbor Road with a 48-inch culvert. Flow then continues SE about 0.4 miles to Friday Harbor across a very gentle valley, crossing University Road with two 48-inch culverts about 200 feet before entering the Bay north of the Port of Friday Harbor Marina.

Town of Friday Harbor - Basin 2 of the watershed is approximately 1,000 acres in size and is in the central portion of the watershed. It is roughly defined by the Town limits; see Figure 17. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that steepen to about 10 percent toward the bottom. The upper basin flow connects into several storm drain improvements in the Town of Friday Harbor, which is an urban area. This flow combines with flow from the 12-inch, 15-inch, and 24-inch storm drain outfalls into Friday Harbor near the ferry landing. Other flows from this basin discharge into the bay west of the Port of Friday Harbor Marina near Tucker Ave in an open ditch or stream flow.

Kansa Cove - Basin 3 of the watershed is several hundred acres in size and is located in the eastern portion of the watershed, in the Turn Point area; see Figure 8. There is a total elevation drop of about 250 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects a wetland and pond areas south of Turn Point Road flowing to the north east toward Pinedrona Lane and Kansa Cove. The flow crosses Turn Point Road with a 24-inch culvert and then continues west about 200 feet before entering the Kansas Cove, near an existing residence.

Critical Resources

Aquatic resources in the watershed are summarized in Table 8.

Table 8. Summary of Aquatic Resources in Friday Harbor Watershed.	
Freshwater Wetlands	522 acres (14%)
Tidal Wetlands	0 acres (0%)
Streams	9.9 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	249 acres (7%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The nearshore marine areas in the Friday Harbor watershed provide habitat for shrimp and shellfish.

Wetland, Aquatic, and Riparian

Aquifer recharge areas are present in the town of Friday Harbor between C Street and Vine Street, and south of the Harbor between Turn Point Road and Pear Point Road. Large wetland areas are north of Beaverton Valley Road, and smaller wetlands appear in patches throughout the watershed, primarily north and west of the town.

Threatened, Endangered, and Species of Local Concern

Forage fish, eelgrass, and kelp are present throughout much of the marine portion of the watershed.

Basin Water Quality Evaluation

Non-point source runoff in the Friday Harbor watershed has been a water quality concern for several years. The San Juan County Watershed Management Action Plan, developed between 1997 and 1999, listed polluted stormwater runoff as a "high priority risk" for Friday Harbor, along with East Sound and False Bay (San Juan County 1999).

Data from the following water quality monitoring programs were reviewed to evaluate major trends in water quality in the Friday Harbor watershed:

- **303(d) Listing Status**
- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The Friday Harbor watershed was monitored during 2002–2008 at the following location:
    - Site BV3 – Creek downstream of the confluence of the two branches of the Beaverton Valley subbasin, at University Road
- **Friday Harbor Labs Science Outreach Program (FHLSOP) – Friday Harbor Marina Water Quality Monitoring Project**: Monitoring data are available for the period 2002–2013 at the following locations:
    - Site 1F – Spring Street stormwater outfall

- Site 2K – Marina site at southeast end of Dock K
- Site 3D – Marina dockside site between C walkway and Commercial Rafting dock
- Site 4H – Marina site at Dock H
- Site 5M – Pier site at Culvert Drive
- Site 6S – Shoreline site at McDonald Street

In situ Parameters

Results from 2002–2013 FHLSOP monitoring indicate that water temperature, dissolved oxygen, and pH levels at the Beaverton Valley creek site have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Friday Harbor (San Juan Channel) is included on the 303(d) list as a Category 5 waterbody impaired for dissolved oxygen (Listing 10111; http://apps.ecy.wa.gov/wats/). Category 5 waterbodies require development and implementation of a TMDL.

Bacteria

Friday Harbor is included on the 303(d) list as a water of concern (Category 2) with respect to bacteria in water (Listing 6637). The listing is based on the marine primary contact recreation, which have fecal coliform criteria of <14 CFU/100 mL (geometric mean), and ≤10 percent of all samples >43 CFU/100 mL (WAC-173-201A-210). For Category 2 waters, Ecology has indicated some evidence of a water quality problem, but not enough for them to require a water quality improvement project at this time.

Results from 2002–2013 FHLSOP monitoring indicate that water in Friday Harbor Marina now meets the primary contact recreation criterion for fecal coliform in all but one location, with an overall trend of general improvement over the monitoring period. Marina dockside sites including 3D, 4H, and 5M, have met the primary contact recreation criterion consistently over the monitoring period; Site 2K has been at this level since 2005 but only met the criterion for secondary contact recreation, sport fishing, boating and aesthetic enjoyment from 2002-2004. Site 6S along the beach has also improved to meet the primary contact recreation criterion for fecal coliform during 2011–2013, after lower ratings throughout the earlier monitoring periods. Site 1F at the Spring Street stormwater outfall has been most consistently impaired; it did not meet fecal coliform criteria from 2002 to 2004, but based on recent data (2011 to 2013) it now meets the criterion for secondary contact recreation (data accessed March 2014 from: http://depts.washington.edu/fhlk12/monitor/monitor.html#marina).

Nutrients

Results from 2002–2013 FHLSOP monitoring indicate that nitrate and ortho-phosphorus concentrations at the Beaverton Valley creek site have not consistently met guidelines adopted by the SJICD (nitrate ≤1 mg/L; ortho-phosphorus ≤0.1 mg/L).

Organic Contaminants

Friday Harbor is included on the 303(d) list as a water of concern (Category 2) with respect to organic compounds in sediment, including 1,2-dichlorobenzene (Listing

514137), 1,2,4-trichlorobenzene (Listing 514138), 1,4-dichlorobenzene (Listing 514139), hexachlorobutadiene (Listing 514144). For Category 2 waters, there is some evidence of a water quality problem, but not enough for the Ecology to require a water quality improvement project at this time.

Risk Summary and Management Recommendations

The Friday Harbor watershed is predominantly residential land use. It contains the large Beaverton Valley wetland system and has the highest percent of wetland area (14 percent) of all the watersheds. There are no lakes over 20 acres but there are just under 10 miles of streams, none fish bearing. Forage fish, eelgrass, and kelp are found within much of the marine nearshore but, in general, there are few protected species or habitats present and marine conditions are somewhat degraded, particularly within the harbor. There are reported flooding problems within the watershed; the majority are documented within the Town of Friday Harbor (see Appendix C). There are also historical water quality concerns for fecal coliform bacteria, dissolved oxygen, nutrients, and organic contaminants. Recent monitoring has indicated reductions in bacteria levels in some sampling locations from historical levels; however, San Juan Channel remains on the 303d list for dissolved oxygen as a Category 5 waterbody, which requires development and implementation of a TMDL. Currently the watershed has about 10 percent impervious area and is one of the few County watersheds to exceed the impervious area threshold where stream degradation is documented to occur. At buildout, impervious area is estimated to be 18.2 percent of the watershed. Given the range of existing water quality concerns (bacteria, dissolved oxygen, nutrients, and organic contaminants), we recommend a continued focus on improving water quality within this watershed. Because much of this watershed is within the Town of Friday Harbor, the County has fairly limited opportunities to manage stormwater runoff directly but there may be opportunities to collaborate with the town for mutual benefit.

Garrison Bay

Land Use

The existing land use in Garrison Bay is a mix of designated forest land, educational services, single family residential, agriculture, and parks (see Table 9).

Stormwater Infrastructure

The watershed is approximately 1,830 acres in size and is in the northwestern portion of San Juan Island. The watershed generally flows to the west into Garrison Bay and consists of one main drainage basin with a defined outlet into the receiving water; see Figure 19. There is a total elevation drop of about 850 feet across the watershed starting at the top of Cady Mountain. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including West Valley Road, Blazing Tree Road, and Yacht Haven Road.

West Valley Road Area - Basin 1 of the watershed is approximately 1,500 acres in size and is located in the northern portion of the watershed; see Figure 20. There is a total elevation drop of about 850 feet across this basin. The basin flow connects a wetland and lake areas

west of West Valley Road and crosses West Valley Road with a 30-inch culvert and then crosses Blazing Tree Road with a 46-inch culvert. Flow then continues north about 1,400 feet across a very gentle valley with wetland areas, crossing Yacht Haven Road with a 60-inch culvert about 100 feet before entering Garrison Bay.

Table 9. Existing Land Use in Garrison Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	251	14%
Manufacturing	0	0%
Residential	395	22%
Resource production and extraction	613	33%
Services	319	17%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	252	14%
Wholesale or retail trade	0	0%
Total	**1,830**	**100%**

Source: San Juan County (2013)

Critical Resources

Aquatic resources in the watershed are summarized in Table10.

Table 10. Summary of Aquatic Resources in Garrison Bay Watershed.

Freshwater Wetlands	128 acres (7%)
Tidal Wetlands	0.8 acre (less than 0.1%)
Streams	4.6 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	0 acres (0%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Sand lance and surf smelt spawning beaches are present primarily in Horseshoe Bay and along the eastern shoreline. The bay is a significant Pacific herring spawning area. Tidal wetlands are present near Garrison Drive and near the stormwater discharge point at the south end of the bay.

Wetland, Aquatic, and Riparian

The watershed contains small patches of both freshwater and tidal wetlands. There are no aquifer recharge areas mapped in the watershed.

Threatened, Endangered, and Species of Local Concern

Important species in the watershed include smelt and herring, clams, Dungeness crab, and bald eagles.

Basin Water Quality Evaluation

Limited data are available for evaluating major trends in water quality in the Garrison Bay watershed. The only known source of data is the following:

- **San Juan County Pilot Stormwater Monitoring Program**:
    - Year 1 data are available for the following locations along San Juan Valley Creek:
        - Site SJ-G1 – Creek culvert under trail on Mitchell Hill property
        - Site SJ-G2 – Garrison Bay Creek at Yacht Haven Road
    - During Year 2 of the pilot monitoring effort, the following additional locations are being sampled:
        - Site SJ-G3 – Garrison Bay (receiving water, receiving water sediments)

In situ Parameters

Data from the 2012-2013 SJC pilot stormwater monitoring effort are limited, with only two to three measurements per parameter, due to lack of flow and site access constraints during the monitoring period. Based on the limited dataset, water temperature and pH levels in the Garrison Bay watershed appear to be generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration with dissolved oxygen greater than 8 mg/L, pH between 7 and 8, and low turbidity (<10 NTU). However, given the small number of samples, additional data are needed to characterize current conditions in the Garrison Bay watershed with certainty (Stillwater Sciences 2014).

Bacteria

Although based on a small sample size (n=3), bacteria data collected during 2012 to 2013 indicated low levels of this constituent in the Garrison Bay watershed. When compared across all six pilot study focus areas, the Garrison Bay watershed sites exhibit geometric mean fecal coliform and *E. coli* levels 5 to 10 times lower than counts in streams in the other focus areas (Stillwater Sciences 2014). Additional data collected during years 2 and 3 should allow for more a definitive comparison between focus areas.

Nutrients

During 2012 and 2013, nutrient concentrations at Garrison Bay sites were low to moderate (nitrate + nitrite nitrogen <0.01–0.4 mg/L; ammonium nitrogen 0.05–0.1 mg/L; organic nitrogen 0.2–0.6 mg/L; total nitrogen 0.5–0.7 mg/L; ortho-phosphorus 10–20 ug/L; total phosphorus <10–50 ug/L) compared with values measured in the other five San Juan County focus areas (Table 3), as well as values measured in Puget Sound Phase 3 monitoring (Ecology and King County 2011) and three national databases of monitored stormwater concentrations (Stillwater Sciences 2014).

Metals

During 2012-2013, total metals were relatively low at Garrison Bay pilot stormwater monitoring sites (arsenic <1 ug/L; cadmium <0.3 ug/L; copper <2 ug/L; lead <0.5 ug/L; zinc <2.5–3 ug/L) compared with reported values for typical urban stormwater runoff and Puget Sound Puget Sound Phase 3 monitoring (Ecology and King County 2011). All dissolved metals were below available Ecology hardness-based acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in Garrison Bay stormwater regarding metals. Since hardness was only collected during the April 5, 2013 storm event, additional data are needed to confirm this result (Stillwater Sciences 2014).

TPHs and Herbicides/Pesticides

Measured concentrations of TPHs (benzene, toluene, ethyl-benzene, total xylenes, and gasoline [C8-C12]) were below the analytical detection limits (0.4–100 ug/L) during 2012-2013 San Juan County pilot stormwater monitoring. Herbicides/pesticides commonly used in San Juan County, including permethrin, MGK-264, and glyphosate, were below the analytical detection limits (0.1–10 ug/L) at Garrison Bay pilot monitoring sites during 2012-2013.

Surfactants

Anionic surfactants measured at Garrison Bay sites during 2012-2013 (0.1–0.6 ug/L) were similar to previous measurements reported for multiple sites across the San Juan Islands (i.e., range = 0.17–1.3 ug/L, mean = 0.57 ug/L; Barsh et al. 2008) and are far below the available USEPA criterion[1] for drinking water sources (500 ug/L).

Risk Summary and Management Recommendations

Garrison Bay is a relatively undeveloped watershed where forestry and farming dominate land uses, followed by residential development. Garrison and neighboring Westcott bays are the primary shellfish harvest areas (mussels, clams, and oysters) on San Juan Island. Garrison Bay, which is bordered by English Camp National Historical Park, is a popular recreational harvesting area. Recent water quality data are limited and indicate no constituents of concern to date. No stormwater problems were reported in this watershed (see Appendix C). Existing impervious cover is 1.1 percent and is expected to rise to 8.7 percent at buildout. Based on the significant increase in development anticipated for this watershed, its proximity to Westcott Bay and the important shellfish beds they share, the CSWAC has selected this watershed and its neighbor Westcott Bay as priority watersheds that should be studied further in connection with Volume 2 of this report to identify appropriate stormwater management strategies.

Griffin Bay

Land Use

The existing land use in Griffin Bay is mostly single family residential, parks, and undeveloped lands over 5 acres in size. Other uses include open space and agriculture (see Table 11).

Stormwater Infrastructure

The watershed is approximately 3,867 acres in size and is in the eastern portion of San Juan Island. The watershed generally flows to the east into Griffin Bay, and consists of four main

drainage basins with defined outlets into the receiving water; see Figure 21. There is a total elevation drop of about 200 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Mullis Street, Argyle Ave., Cattle Point Road, and Golf Course Road.

Table 11. Existing Land Use in Griffin Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	789	20%
Manufacturing	11	0%
Residential	1,559	40%
Resource production and extraction	374	10%
Services	47	1%
Transportation, communication and utilities	173	4%
Undeveloped land and water areas	907	23%
Wholesale or retail trade	7	0%
Total	**3,867**	**100%**

Source: San Juan County (2013)

Airport - Basin 1 of the watershed is approximately 100 acres in size and is located in the northern portion of the watershed; see Figure 22. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 2 percent in the middle portion that flatten to about 1 percent toward the bottom. The upper basin flow includes the Friday Harbor Airport and residential area to the east of the airport, both within the Town of Friday Harbor limits, and crosses Mullis Street with a 24-inch culvert and then crosses Argyle Avenue with an 18-inch culvert. Flow then continues SE about 800 to North Bay across a gentle valley with ponded areas, crossing Kelley Lane with an 18-inch and North Bay Road with a 48-inch culvert before entering North Bay, near Jackson Beach.

Burton Road - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 23. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas west of Cattle Point Road and combines into stream flow heading east for about 1,000 feet to Cattle Point Road. The flow crosses Cattle Point Road in a 36-inch culvert, and continues down a stream course for about 600 feet and finally crosses Mill Street with a 32-inch culvert about 40 feet before entering North Bay.

Golf Course - Basin 3 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 24. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The

basin flow south of Little Road and west of Cattle Point Road crosses Cattle Point road with an 18-inch culvert and forms a stream that flows east for about 2,000 feet, connecting several wetland and pond areas. The flow crosses Golf Course Road with a 30-inch culvert and then continues west about 100 feet before entering Merrifield Cove.

Heritage Farm Lane - Basin 4 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 25. There is a total elevation drop of about 300 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas east of Cattle Point Road near Heritage Farm Lane and crosses Cattle Point Road with a 36-inch culvert and then continues west about 3,000 feet in a stream and through ponds before entering Mulno Cove.

Critical Resources

Aquatic resources in the watershed are summarized in Table 12.

Table 12. Summary of Aquatic Resources in Griffin Bay Watershed.

Freshwater Wetlands	141 acres (4%)
Tidal Wetlands	4.3 acres (0.1%)
Streams	5.9 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	866 acres (22%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The nearshore marine areas in the watershed provide habitat for shrimp and shellfish, particularly near barrier beaches and pocket estuaries at Jakles Lagoon and Fish Creek, and near Cattle Point Road and Pear Point Road in North Bay. Smelt spawning beaches are present near Jensen Bay Road and Pear Point Road. The shoreline contains a patchy distribution of kelp and eelgrass.

Wetland, Aquatic, and Riparian

The watershed contains several aquifer recharge areas along Cattle Point Road, Jensen Bay Road, and Pear Point Road.

Threatened, Endangered, and Species of Local Concern

Species in this watershed include smelt, kelp and eelgrass, and bald eagles.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Griffin Bay watershed.

Risk Summary and Management Recommendations

Griffin Bay is dominated by residential land use but is also home to a number of parks. The watershed has a rich nearshore and marine environment overall. There is no water quality data for the watershed sufficient to comment on conditions. The stormwater reporting website results indicate seven reports, the majority related to flooding. Existing impervious area is relatively high compared to other watersheds at 7.6 percent. It is expected to nearly double to 14.4 percent under buildout conditions. This watershed we feel is a candidate for monitoring as it has a rich shoreline ecosystem and numerous stream that discharge to Griffin Bay. Although there are few known stormwater management issues in this watershed, there are also a paucity of data. Stream monitoring would be useful to evaluate whether there are water quality issues and to establish a baseline for assessing whether degradation occurs in the future.

Haro Strait

Land Use

The existing land use in Haro Strait is mostly single-family residential and undeveloped lands over 5 acres in size. Other uses include agriculture and open space (see Table 13).

Table 13. Existing Land Use in Haro Strait.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	64	2%
Manufacturing	0	0%
Residential	1,761	53%
Resource production and extraction	501	15%
Services	0	0%
Transportation, communication and utilities	4	0%
Undeveloped land and water areas	1,022	30%
Wholesale or retail trade	0	0%
Total	**3,353**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 3,353 acres in size and is in the western portion of San Juan Island. The watershed generally flows to the west into Haro Strait and consists of two main drainage basins with defined outlets into the receiving water; see Figure 26. There is a total elevation drop of about 1,000 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses West Side Road in culverts in several locations.

Andrews Bay - Basin 1 of the watershed is approximately 1,000 acres in size and is located in the northern portion of the watershed; see Figure 27. There is a total elevation drop of about 600 feet across this basin. The basin is characterized by steep slopes in the upper portion,

gentle slopes up to about 2 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and lake areas west of Lawson Road, then flows in a stream for about 8,000 feet to West Side Road where it crosses within a 48-inch culvert about 200 feet before entering Andrews Bay.

Westside Lake - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 28. There is a total elevation drop of about 1,000 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that steepen toward the bottom. The basin flow connects starts at the top of the Mount Dallas ridge and is captured by Westside Lake as it flows west. Westside Lake outlets to the south in a stream course for 1,400 feet and finally crosses West Side Road with a 36-inch culvert about 600 feet before entering Deadman Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 14.

Table 14. Summary of Aquatic Resources in Haro Strait Watershed.

Freshwater Wetlands	189 acres (6%)
Tidal Wetlands	0 acres (0%)
Streams	5.6 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	317 acres (9%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Primary stormwater discharge points are at Andrews Bay and Smallpox Bay. The marine shoreline is characterized by wave action and swell, and bedrock formations and pocket beaches that make the shoreline unique compared to many other watershed in the San Juans.

Wetland, Aquatic, and Riparian

Wetlands are primarily associated with stream channels along West Side Road and immediately west of Lawson Road. Aquifer recharge areas are present and the southern and northern extents of the watershed, near Smugglers Cove Road and near West Side Road and MacGinitie Road.

Threatened, Endangered, and Species of Local Concern

Species in the watershed include red sea urchin and bald eagles in the nearshore marine areas. The shoreline contains extensive kelp forests. Geoduck beds are present of the shore north of Pile Point.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Haro Strait watershed.

Risk Summary and Management Recommendations

Haro Strait has a high percentage of residential development but is relatively undeveloped otherwise. Six percent of the watershed is freshwater wetland and there are 5.6 miles of stream; none are fish bearing. There are large kelp forests in the very energetic nearshore. There are no water quality data available and few reports of stormwater problems. Impervious cover is currently 1.8 percent and estimated to rise to 8.8 percent at buildout. Although there are no known problems, this watershed is recommended for monitoring to establish a baseline for understanding future changes that might occur as the watershed develops.

Juan de Fuca Strait

Land Use

The existing land use in Juan de Fuca Strait is a mix of parks, single-family residential, open space and agriculture (see Table 15).

Table 15. Existing Land Use in Juan de Fuca Strait.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	586	34%
Manufacturing	0	0%
Residential	425	25%
Resource production and extraction	216	12%
Services	26	1%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	478	28%
Wholesale or retail trade	0	0%
Total	**1,732**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,732 acres in size and is in the south portion of San Juan Island. The watershed generally flows to the south into Juan de Fuca Strait and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 29. There is a total elevation drop of about 250 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 2 percent near the shoreline. The watershed flow crosses one county road with a culvert.

False Bay Drive - Basin 1 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 30. There is a total elevation drop of about 250 feet across this basin. The basin flow begins at the Portland Fair Road area and flows south across a wetland area crossing False Bay Drive with an 12-inch culvert and continuing

south through several wetland and pond areas and forming a stream flowing about 5,000 feet before entering the Juan de Fuca Strait.

Critical Resources

Aquatic resources in the watershed are summarized in Table 16.

Table 16. Summary of Aquatic Resources in Juan de Fuca Strait Watershed.	
Freshwater Wetlands	52 acres (3%)
Tidal Wetlands	0 acres (0%)
Streams	2.1 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	126 acres (23%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The Juan de Fuca straight watershed shares similar characteristics and critical areas resources as the Haro Strait watershed. Tidal wetlands are absent due to the bedrock character of the shoreline.

Wetland, Aquatic, and Riparian

Small wetland areas are distributed throughout the watershed, primarily north of Eagle Cover Drive. There are extensive aquifer recharge areas (126 acres) including most of the American Camp area.

Threatened, Endangered, and Species of Local Concern

Species present include bald eagles, red sea urchin, and extensive kelp forests similar to the Haro Strait watershed. There is also eelgrass present near the pocket beach in Eagle Cove.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Juan de Fuca Strait watershed.

Risk Summary and Management Recommendations

Juan de Fuca Strait is predominantly federal and state park land use followed by residential. Only 3 percent of the watershed is freshwater wetlands, there are no significant lakes, and there are 2.1 miles of streams. Twenty-three percent of the watershed is within an aquifer recharge area. There are extensive kelp forests as in the Haro Strait nearshore. Water quality data are unavailable and only one stormwater problem was reported (see Appendix C). Impervious cover is currently 4.5 percent and is estimated to increase to 10.2 percent at buildout. Although that is a significant increase, we recommend this watershed be a low priority for stormwater management, largely because so much of it sheet flows directly to Haro Strait and stormwater interception opportunities are limited.

Mitchell Bay

Land Use

The existing land use in Mitchell Bay is mostly single-family residential (see Table 17).

Table 17. Existing Land Use in Mitchell Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	3	1%
Manufacturing	0	0%
Residential	393	74%
Resource production and extraction	24	5%
Services	5	1%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	103	19%
Wholesale or retail trade	0	0%
Total	**529**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 529 acres in size and is in the northwestern portion of San Juan Island. The watershed generally flows to the south into Mitchell Bay and consists of two main drainage basins with defined outlets into the receiving water; see Figure 31. There is a total elevation drop of about 250 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including West Side Road, Mitchell Bay Road, and Yacht Haven Road.

Blackfish Pond - Basin 1 of the watershed is over 100 acres in size and is located in the southern portion of the watershed; see Figure 32. There is a total elevation drop of about 250 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that steepen toward the shoreline. The basin flow connects Blackfish Pond to a wetland area east of West Side Road crossing the road with a 12-inch culvert and then crossing Mitchell Bay Road with a 18-inch culvert. Flow then continues north about 800 feet before entering Mitchell Bay. There are residences near the outlet point.

Arbutus Lane - Basin 2 of the watershed is less than 100 acres in size and is located in the northern portion of the watershed; see Figure 33. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that steepen toward the shoreline. The basin flow collects a wetland area north of Yacht Haven Road crossing the road with two 12-inch and then flowing south about 800 feet before entering Mitchell Bay. There are residences near the outlet point.

Critical Resources

Aquatic resources in the watershed are summarized in Table 18.

Table 18. Summary of Aquatic Resources in Mitchell Bay Watershed.	
Freshwater Wetlands	13 acres (2%)
Tidal Wetlands	0 acres (0%)
Streams	0.7 mile (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	126 acres (23%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Pacific Herring spawning areas are present near the outlet of Mitchell Bay. Although absent from the marine shoreline in the watershed, a smelt spawning beach is documented near Intrepid Lane along the southern shoreline of Mitchell Bay.

Wetland, Aquatic, and Riparian

Riparian and wetland habitat is primarily associated with the small stream that crosses Yacht Haven Road and enters Mitchell Bay from the north. There are also small wetlands adjacent to Mitchel Bay Road near Briggs Road. Along Mitchell Bay Road west of Briggs Road, the western portion of the watershed south of the bay contains an aquifer recharge area.

Threatened, Endangered, and Species of Local Concern

Fish species in the watershed include smelt and herring. Bald eagle roosts are present along much of the marine shoreline. There is a patchy distribution of eelgrass, near Arbutus Lane and De Haro Lane.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Mitchell Bay watershed.

Risk Summary and Management Recommendations

The Mitchell Bay watershed has one of the highest percentages of residential development among all the watersheds of 70 percent. It is a relatively small watershed as well at 529 acres. Two percent is freshwater wetland and there are 0.7 miles of streams (non-fish bearing). About 23 percent of the watershed is within an aquifer recharge area. Smelt and herring spawn on many shoreline beaches in this watershed. There are no water quality data available and no stormwater problem reports submitted. Existing impervious cover is 3.8 percent and is expected to rise to 9.6 percent at buildout. Much of this watershed sheet flows to Mitchell Bay and stormwater interception opportunities are limited. That, combined with no evidence of stormwater problems suggests that this watershed be low priority for stormwater management.

Roche Harbor

Land Use

The existing land use in Roche Harbor is a mix of single-family residential, undeveloped lands over 5 acres, and other undeveloped lands (see Table 19).

Table 19. Existing Land Use in Roche Harbor.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	17	6%
Manufacturing	0	0%
Residential	133	48%
Resource production and extraction	0	0%
Services	0	0%
Transportation, communication and utilities	21	8%
Undeveloped land and water areas	103	37%
Wholesale or retail trade	2	1%
Total	**277**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 277 acres in size and is in the northern portion of San Juan Island. The watershed generally flows to the west into Roche Harbor and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 34. There is a total elevation drop of about 200 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that steepen near the shoreline. The watershed flow crosses no county roads in culverts.

Roche Harbor Resort - Basin 1 of the watershed is less than a hundred acres in size and is located in the central portion of the watershed; see Figure 35. There is a total elevation drop of about 200 feet across this basin. The basin flow begins at two gentle hills and flows through the resort's private road system to the northwest about 800 feet before entering Roche Harbor near the Roche Harbor Marina.

Critical Resources

Aquatic resources in the watershed are summarized in Table 20.

Table 20. Summary of Aquatic Resources in Roche Harbor Watershed.

Freshwater Wetlands	5 acres (2%)
Tidal Wetlands	9.0 acres (3.2%)
Streams	0.1 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer recharge areas	0 acres (0%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The nearshore along Bazalgette Point Drive is a documented Pacific herring spawning area. Roach Harbor also contains habitat used by red sea urchin and Dungeness crab. Tidal wetlands are associated with pocket estuaries in in the southern part of the watershed near White Point Road and Seal Rock Lane.

Wetland, Aquatic, and Riparian

Wetlands are limited to relatively small patches in the Roche Harbor watershed. They are mostly well vegetated or have forested buffers. There are no aquifer recharge areas mapped in the watershed.

Threatened, Endangered, and Species of Local Concern

Species present include herring, sea urchin, and crab. Bald eagle nesting and roosting areas cover the entire marine shoreline except for the developed area in the immediate vicinity of Reuben Memorial Drive and the marina.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Roche Harbor watershed.

Risk Summary and Management Recommendations

The Roche Harbor watershed is predominantly residential but has a high proportion of undeveloped land. Only 2 percent of the watershed is freshwater wetlands but there are 9 acres of intertidal wetlands comprising 3.2 percent of the watershed. There is a short 0.1 mile of stream and no lakes over 20 acres. The intertidal and nearshore areas of this watershed are home to important protected species. No water quality data are available and there were no stormwater problem reports submitted. Existing impervious cover is relatively high at 9.2 percent. It is estimated to increase to 16.2 percent at buildout. This is relatively speaking a low increase compared to most other County watersheds suggesting that the Roche Harbor watershed is likely one of the closest to buildout conditions of any watershed. In addition, much of this watershed sheet flows to Roche Harbor and stormwater interception opportunities are limited. These factors, combined with no evidence of stormwater problems suggests that this watershed be low priority for further stormwater management.

San Juan Channel (San Juan)

Land Use

The existing land use in San Juan Channel (San Juan) watershed is mostly a mix of single-family residential and designated forest land. There are also undeveloped lands over 5 acres in size (see Table 21).

Stormwater Infrastructure

The watershed is approximately 5,571 acres in size and is in the northeastern portion of San Juan Island. The watershed generally flows to the east into San Juan channel and consists of three main drainage basins with defined outlets into the receiving water; see Figure 36. There is a total elevation drop of about 850 feet across the watershed from the top of Cady

Mountain. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Roche Harbor Road, and Egg Lake Road.

Table 21. Existing Land Use in San Juan Channel (San Juan).

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	36	1%
Manufacturing	1	0%
Residential	2,431	44%
Resource production and extraction	1,757	32%
Services	225	4%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	1,113	20%
Wholesale or retail trade	6	0%
Total	**5,571**	**100%**

Source: San Juan County (2013)

Firwood Lane - Basin 1 of the watershed is about 200 acres in size and is located in the northern portion of the watershed; see Figure 37. There is a total elevation drop of about 350 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 2 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and lake areas south of Roche Harbor Road and crosses Roche Harbor Road with an 18-inch culvert and then combines with flow from the north and continues east in a stream course for about 3,000 feet before entering Rocky Bay.

Dream and Neva Lake - Basin 2 of the watershed is nearly 1,000 acres in size and is located in the central portion of the watershed; see Figure 38. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that steepen as they approach the shoreline. The basin flow connects several wetland and lake areas south of Roche Harbor Road and crosses Roche Harbor Road with a 36-inch culvert and flows in a stream to the north along Rocky Bay Road about 2000 feet before entering Rocky Bay.

Sportsmans Lake - Basin 3 of the watershed is nearly 2,000 acres in size and is located in the southern portion of the watershed; see Figure 39. There is a total elevation drop of about 850 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas near Three Corner Lakes Road, flowing to the east and crossing Egg Lake road with a 36-inch culvert and several smaller culverts. Flows combine in Egg Lake and then flow east to Sportsmans Lake which outlets to the east and crosses Roche Harbor Road with a 48-inch culvert and then continues east about 3,000 feet before entering San Juan Channel.

Critical Resources

Aquatic resources in the watershed are summarized in Table 22.

Table 22. Summary of Aquatic Resources in San Juan Channel (San Juan) Watershed.	
Freshwater Wetlands	526 acres (9%)
Tidal Wetlands	0 acres (0%)
Streams	18.9 miles (0.7 mile fish-bearing)
Significant Lakes	Dream Lake (23 acres) Sportsmans Lake (66 acres)
Aquifer Recharge Areas	228 acres (4%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The shoreline is primarily forested, but steep and rocky. The shoreline lacks estuarine habitat except for a small pocket area in Rocky Bay. The nearshore habitat is suitable for urchins along the entire shoreline, and for pandalid shrimp near Rocky Bay and O'Neal Island.

Wetland, Aquatic, and Riparian

A significant portion of the watershed drains to Sportsman Lake before flowing to the San Juan Channel. Dream Lake drains to the southern side of Rocky Bay and small streams and wetlands north of Roche Harbor Road drain west to the pocket estuary in Rocky Bay. Wetlands include lake fringe wetlands and small patches associated with streams and distributed throughout the watershed. Significant aquifer recharge areas are located south of Limestone Point Road, along Egg Lake Road and Three Corner Lake Road, and the vicinity of Bull Run Road.

Threatened, Endangered, and Species of Local Concern

Species include sea urchins and shrimp. Eelgrass distribution is patchy close to the shoreline. Bald eagle perches and potential nesting areas are present along the majority of the shoreline.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the San Juan Channel watershed.

Risk Summary and Management Recommendations

San Juan Channel is predominantly residential land use followed by forestry and agriculture uses. It has two large lakes and numerous small ones. Nine percent of the watershed is freshwater wetland and there are 18.9 miles of streams; 0.7 miles being fish bearing. Much of the watershed drains to the freshwater features before exiting to San Juan Channel. The shore is mostly steep and rocky but there are patch eelgrass beds present. There are no water quality data available but three reports of erosion and flooding problems were submitted (see Appendix C). Existing impervious area is 1.6 percent and is estimated to increase to

9.1 percent at buildout. Based on the significant stream, wetland, and lake system present in this watershed and the extent of anticipated future impervious surfaces from development, we recommend that the San Juan Channel watershed be a candidate for water quality monitoring. The goal of this monitoring would be to validate that there are no water quality issues present today and set a baseline for assessing the impact of future development. It is also a watershed that may begin to show more evidence of flooding and erosion problems as more development occurs due to the many steep slopes present.

Spieden Channel

Land Use

The existing land use in Spieden Channel is mostly single-family residential with some non-habitable improvements on land over 5 acres in size (see Table 23).

Table 23. Existing Land Use in Spieden Channel.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	11	1%
Manufacturing	0	0%
Residential	465	64%
Resource production and extraction	27	4%
Services	2	0%
Transportation, communication and utilities	19	3%
Undeveloped land and water areas	206	28%
Wholesale or retail trade	0	0%
Total	**730**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 730 acres in size and is in the northern portion of San Juan Island. The watershed generally flows to the north into Spieden Channel and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 40. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that steepen near the shoreline. The watershed flow crosses Petrich Road and Limestone Point Road in culverts.

Petrich Road - Basin 1 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 41. There is a total elevation drop of about 150 feet across this basin. The basin flow begins at two gentle hills and flows along the ditch line of Flint Road to the north about 1,200 feet, crossing Petrich Road with two 12-inch culverts and crossing four other private roads and about 2,000 feet of stream course before entering the Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 24.

Table 24. Summary of Aquatic Resources in Spieden Channel Watershed.	
Freshwater Wetlands	27 acres (4%)
Tidal Wetlands	0 acres (0%)
Streams	0.9 mile (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	36 acres (5%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The shoreline lacks shallow nearshore habitat and beach formations that would support a variety of clam and forage fish species. Chinook salmon and high densities of chum and pink salmon use the Lonesome Cove shoreline off of Spieden Channel (Wyllie-Echeverria and Barsh 2007). This general area, at the convergence of Spieden, President, and San Juan Channels, has relatively high juvenile salmon densities in the nearshore areas compared to other nearshore locations in the County.

Wetland, Aquatic, and Riparian

The largest wetlands are associate with the headwaters of the small streams in the watershed. The aquifer recharge areas in this watershed comprises the northern portion of the area primarily in the San Juan Channel and Westcott Bay watersheds, south of Limestone Point Road and on both side of Rouleau Road.

Threatened, Endangered, and Species of Local Concern

While the entire County is likely very important for salmonids, nearshore areas in this region may have even more significance for juvenile salmon migration and success compared to other regions in County. Shorelines along the western half of the watershed, including Davison Head, provide bald eagle roosts and potential nesting areas.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Spieden Channel watershed.

Risk Summary and Management Recommendations

Spieden Channel watershed is predominantly residential development land use and has very little agriculture or forestry. There is just under 1 mile of streams (non-fish bearing) and 4 percent of the watershed is freshwater wetlands. This watershed's nearshore is heavily used by juvenile salmon migrating through the islands. There are no water quality data for this watershed. There was one stormwater problem report of inadequate ditch capacity (see Appendix C). Existing impervious area is 4.5 percent and is estimated to increase to 11.1 percent at buildout. Much of this watershed sheet flows to Spieden Channel and

stormwater interception opportunities are limited. This factor, combined with no evidence of stormwater problems suggests that this watershed be low priority for stormwater management.

Westcott Bay

Land Use

The existing land use in Westcott Bay is mostly designated forest land. Other uses include parks, single-family residential, and undeveloped lands over 5 acres in size (see Table 25).

Table 25. Existing Land Use in Westcott Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	328	18%
Manufacturing	0	0%
Residential	231	13%
Resource production and extraction	1,016	56%
Services	0	0%
Transportation, communication and utilities	36	2%
Undeveloped land and water areas	212	12%
Wholesale or retail trade	0	0%
Total	**1,822**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,822 acres in size and is in the northwestern portion of San Juan Island. The watershed generally flows to the west into Westcott Bay and consists of three main drainage basins with defined outlets into the receiving water; see Figure 42. There is a total elevation drop of about 300 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Roche Harbor Road, West Valley Road, and Westcott Drive.

Roche Harbor Airstrip - Basin 1 of the watershed is less than 100 acres in size and is located in the northern portion of the watershed; see Figure 43. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow collect the flow from about 30 aircraft hangar homes and the runway area with ditching that flows to the west and crosses Roche Harbor road with a 30-inch culvert about 800 feet before entering the Bay.

Rouleau Road - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 44. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the upper and middle portions that flatten to about

1 percent toward the bottom. The basin flow connects several wetland and lake areas. The basin flow connects several wetland areas north and east of Roche Harbor Road, flowing to the west. The flow crosses West Valley Road with a 30-inch culvert and flows about 2,000 feet in a stream that crossing Westcott Drive with a 24-inch culvert and then continues west about 200 feet before entering Westcott Bay. There are residences near the outlet into the Bay.

Roche Harbor Lake - Basin 3 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 45. There is a total elevation drop of about 300 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland areas around Roche Harbor Lake east of West Valley Road, flowing to the west. The flow crosses West Valley Road with a 30-inch culvert and flows about 2,000 feet in a stream that crossing Westcott Drive with a 24-inch culvert and then continues west about 200 feet before entering Westcott Bay. There are residences near the outlet into the Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 26.

Table 26. Summary of Aquatic Resources in Westcott Bay Watershed.

Freshwater Wetlands	100 acres (5%)
Tidal Wetlands	1.9 acres (0.1%)
Streams	2.2 miles (0 miles fish-bearing)
Significant Lakes	Roche Harbor Lake (29 acres)
Aquifer Recharge Areas	89 acres (5%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Westcott Bay is a significant spawning area for Pacific herring. The forested shoreline also provides habitat for smelt spawning, and the north shoreline contains suitable habitats to support oyster beds. There is also a tidal wetland mapped at the north end of the bay, south of Roche Harbor Road.

Wetland, Aquatic, and Riparian

Roche Harbor Lake is a dammed reservoir draining to Westcott Bay. Wetlands are associated with the lake shoreline, and patches north of Roche Harbor Road. The aquifer recharge area mapped in this watershed comprises the western portion of the same area mapped within the adjacent San Juan Channel and Spieden Channel watersheds.

Threatened, Endangered, and Species of Local Concern

Species in the watershed include Pacific herring, smelt, Dungeness crab, and bald eagles. However, potential roosting and nesting sites for bald eagles is somewhat limited compared to other watersheds on San Juan Island.

Basin Water Quality Evaluation

Limited data are available for evaluating trends in water quality in the Westcott Bay watershed. Data from the following programs were reviewed:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The Westcott Bay watershed was monitored during 2006–2008 at the following location:
  - WB7 – Seasonal stream at Westcott Drive just before the Westcott Bay Sea Farms property
- **DOH Receiving Water Coliform Monitoring**

In situ Parameters

Results from 2006–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, pH, and turbidity levels in the seasonal stream at Westcott Drive have been supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Bacteria

Bacteria data collected during the 2006–2008 FHLSOP indicate that fecal coliform levels in the seasonal stream at Westcott Drive have varied but have generally met criteria for the primary contact recreation beneficial use, with annual geometric mean values consistently <100 CFU/100 mL. One instantaneous count (1 of 22 samples, or 6 percent) at this location was greater than 200 CFU/100 mL during the monitoring period.

Based on monthly data collected by the DOH, fecal coliform in Westcott Bay ranged from 1.7 to 22 CFU/100 mL from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation uses in Westcott Bay.

Nutrients

Results from 2006–2008 FHLSOP monitoring indicate that ortho-phosphorus and nitrate concentrations in the seasonal stream at Westcott Drive have consistently met guidelines adopted by the SJICD (nitrate ≤1 mg/L; ortho-phosphorus ≤0.1 mg/L).

Risk Summary and Management Recommendations

Westcott Bay watershed is predominantly forest land, parks, and some residential housing. The watershed is 5 percent freshwater wetlands and there is one large lake as well as a number of smaller ones. There are 2.2 miles of streams that are not fish bearing. Westcott Bay is a rich Pacific herring and surf smelt spawning area as well as the major shellfish harvesting area on San Juan Island. There is an active sea farm present in the watershed. Recent water quality data are limited and indicate no constituents of concern to date, however monitoring in 1997 found elevated bacteria and total suspended solids at some sampling locations (SJC 2000). No stormwater problems were reported in this watershed (see Appendix C). Existing impervious cover is 3.2 percent and is expected to rise to 15.5 percent

at buildout. This is the highest increase in impervious area projected for County watersheds. Based on the significant increase in development anticipated for this watershed, and its proximity to Garrison Bay and the important shellfish beds they share, the CSWAC has selected this watershed and its neighbor Garrison Bay as priority watersheds that should be studied further in connection with Volume 2 of this report to identify appropriate stormwater management strategies.

Orcas Island

Deer Harbor

Land Use

The existing land use in Deer Harbor is mostly a mix of single-family residential, designated forest land, and undeveloped lands over 5 acres in size (see Table 27).

Table 27. Existing Land Use in Deer Harbor.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	74	4%
Manufacturing	0	0%
Residential	827	49%
Resource production and extraction	333	20%
Services	1	0%
Transportation, communication and utilities	2	0%
Undeveloped land and water areas	440	26%
Wholesale or retail trade	2	0%
Total	**1,679**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,679 acres in size and is in the western portion of Orcas Island. The watershed generally flows to the south into Deer Harbor and consists of four main drainage basins with defined outlets into the receiving water; see Figure 46. There is a total elevation drop of about 400 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, and gentle slopes up to about 5 percent in the middle portion, which generally steepen toward the shoreline. The watershed flow crosses several county roads in culverts including Channel Road, Deer Harbor Road, and Cormorant Bay Road.

Channel Road - Basin 1 of the watershed is several hundred acres in size and is in the western portion of the watershed; see Figure 46. There is a total elevation drop of about 400 feet across this basin. The basin is characterized by steep slopes in the upper portion, and gentle slopes up to about 2 percent in the middle portion, which steepen at the shoreline. The basin flow connects several wetland and Jay's Pond at Spring Point flowing to the north and combining with other flows from the north and west into a wetland and pond area north of

Channel Road. The outlet flow is to the east and crosses Channel Road with a 24-inch culvert about 200 feet before entering the Deer Harbor.

Deep Meadow Lane - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 48. There is a total elevation drop of about 400 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetlands north of Cormorant Bay Road in the Deep Meadow Lane area, crossing Cormorant Bay Road with an 18-inch culvert and several other smaller culverts while flowing south another 1,000 feet to the shoreline at Cayou Caye. Water then flows into Deer Harbor under a bridge at Channel Road.

Gaggs Road - Basin 3 of the watershed is less than 100 acres in size and is located in the central portion of the watershed; see Figure 49. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper and middle portions that flatten to about 5 percent toward the bottom. The basin flow begins in an area north of Gaggs Road and is captured by the ditch on Deer Harbor Road flowing south and west. The flow crosses Deer Harbor Road with a 15-inch culvert and flows another 600 feet to the shoreline in Deer Harbor.

Ralph Gott Road - Basin 4 of the watershed is approximately 100 acres in size and is located in the southern portion of the watershed; see Figure 50. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper portion that flatten to about 2 percent toward the bottom. The basin flow begins from two gentle hills and combines in a wetland area that flows out to the south crossing Deer Harbor Road with a 18-inch culvert and flows about 400 feet south in a stream to a 24-inch storm drain outfall that crosses under Windward Ln and continues about 400 feet to the shoreline.

Critical Resources

Aquatic resources in the watershed are summarized in Table 28.

Table 28. Summary of Aquatic Resources in Deer Harbor Watershed.

Freshwater Wetlands	113 acres (7%)
Tidal Wetlands	0.7 acres (less than 0.1%)
Streams	3.2 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	20 acres (1%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Marine sea birds are commonly seen along the shorelines and may use nearshore areas to feed on forage fish. A small stream drains to Dear Harbor and forms a somewhat large pocket estuary in the northern part of the harbor above Channel Road, and includes a tidal emergent wetland area that somewhat unique in the watershed and region.

Wetland, Aquatic, and Riparian

Wetland areas are scattered throughout the watershed with notably large areas to the north of Channel Road and the vicinity of Ralph Gott Road and Four Winds Road, and in the northern part of the watershed near Deep Meadow Lane. There are five perennial or ephemeral streams that drain to Dear Harbor or Pole Pass. There are two relatively small critical aquifer recharge areas in the watershed: one along Channel Road at the western boundary of the watershed and one along Deer Harbor Road at its southern extent.

Threatened, Endangered, and Species of Local Concern

Species present include Dungeness crab and sea urchin. Eelgrass extends along the eastern shoreline of Deer Harbor, while kelp is dominates the western shoreline. Bald eagles have been documented at the southern extent of the watershed along the shoreline near Deer Harbor Road, but shoreline throughout the rest of the management area for nesting and roosting may be limited.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Deer Harbor watershed.

Risk Summary and Management Recommendations

The Deer Harbor watershed has some forestry and agriculture but is predominantly residential land use. Seven percent of the watershed is freshwater wetlands and there are 3.2 miles of streams. There is a unique system of freshwater and intertidal wetland that creates estuary conditions north of the Deer Harbor Bridge. There are reports of flooding along the south side of Channel Road. There are no water quality data available for this watershed. Existing impervious area is 3.4 percent and is estimated to increase to 11.1 percent at buildout. There are few known flooding problems and no known water quality problems in the watershed and only modest increases in impervious surfaces are expected under full buildout conditions; therefore, this watershed should be a lower priority for further study and stormwater management.

Doe Bay

Land Use

The existing land use in Doe Bay is mostly a mix of single-family residential, parks, designated forest land and undeveloped lands over 5 acres in size (see Table 29).

Stormwater Infrastructure

The watershed is approximately 3,622 acres in size and is in the eastern portion of Orcas Island. The watershed generally flows to the south into Doe Bay and consists of four main drainage basins with defined outlets into the receiving water; see Figure 51. There is a total elevation drop of about 1,700 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Obstruction Pass Road, Point Lawrence Road, and Alderbrook Drive.

Table 29. Existing Land Use in Doe Bay.		
Generalized Land Use Category	**Acres**	**Percentage of Total Basin**
Cultural, entertainment and recreational	829	23%
Manufacturing	0	0%
Residential	1,302	36%
Resource production and extraction	807	22%
Services	0	0%
Transportation, communication and utilities	8	0%
Undeveloped land and water areas	676	19%
Wholesale or retail trade	0	0%
Total	**3,622**	**100%**

Source: San Juan County (2013)

Buoy Bay - Basin 1 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 52. There is a total elevation drop of about 250 feet across this basin. The basin is characterized by gentle upper and middle slopes up to about 5 percent that flatten to about 2 percent toward the bottom. The basin flow connects several wetland and lake areas south of Obstruction Pass Road in the Trailhead Road area, and then crosses Obstruction Pass Road with an 18-inch culvert. Flow continues northeast across a gentle valley with wetland and pond areas, then flowing to the east in a stream about 1,000 feet before entering the Bay. Residences are located in close proximity to the outlet at the shoreline.

Roehls Hill - Basin 2 of the watershed is approximately 100 acres in size and is located in the central portion of the watershed; see Figure 53. There is a total elevation drop of about 1,050 feet across this basin. The basin is characterized by steep slopes in the upper, middle, and lower portions. The basin flow combines into a stream that flows south about 5,000 feet down the mountain side and crosses Point Lawrence Road with a 27-inch culvert at about 500-foot elevation before entering the Bay.

Doe Bay Road - Basin 3 of the watershed is nearly 1,000 acres in size and is located in the central portion of the watershed; see Figure 54. There is a total elevation drop of about 1,700 feet across this basin. The basin is characterized by very steep slopes in the western upper portion and about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas east of Point Lawrence road and crosses the road with a 60-inch culvert. There it combines with flows from the north in a stream flowing to the south for about 3,000 feet and then crosses Point Lawrence Road with a 48-inch culvert and continues south about 300 feet in the stream before entering Doe Bay near Doe Bay Resort.

Eagle Lake - Basin 4 of the watershed is 700 acres in size and is located in the eastern portion of the watershed; see Figure 55. There is a total elevation drop of about 1,700 feet across this basin. The basin is characterized by very steep slopes in the western upper portion and about 10 percent in the middle portion that flatten to about 5 percent toward the bottom.

The basin flow collects into Eagle Lake which has an earthen dam and concrete spillway that forms an outlet stream flowing to the south and east about 4,000 feet and then crossing Alderbrook Drive with a 48-inch culvert and continues east about 2,000 feet in the stream before entering the Bay. Residences are located in close proximity to the outlet at the shoreline.

Critical Resources

Aquatic resources in the watershed are summarized in Table 30.

Table 30. Summary of Aquatic Resources in Doe Bay Watershed.

Freshwater Wetlands	102 acres (3%)
Tidal Wetlands	0 acres (0%)
Streams	10.1 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	484 acres (13%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Near-surface bedrock dominates the geomorphology of the shoreline in the Doe Bay watershed. Estuarine habitat is limited but there are several small pocket estuaries supporting eelgrass and providing nearshore habitat for a variety of species. The shoreline and smaller islands primarily provide suitable habitat for sea urchins, kelp, and species that rely on these conditions for habitat. Seabird and marine mammal haul outs are common among the small islands.

Wetland, Aquatic, and Riparian

Wetlands in this watershed are relatively small with a patchy distribution throughout the watershed. However, there are relatively large critical aquifer recharge areas in the central portion of the watershed along Point Lawrence Road and surrounding Buoy Bay along Buoy Bay Road and Deer Point Road. Smaller areas are also present near the shoreline. There are seven perennial streams, the largest of which drains into Doe Bay.

Threatened, Endangered, and Species of Local Concern

Species present include sea urchin, bald eagle, kelp, and eelgrass. Relatively undisturbed forest cover along the shoreline provides habitat for bald eagles, primarily north of Doe Bay. The shoreline contains a relatively continuous patch of kelp between Doe Bay and Sea Acres Road. Eelgrass is common in the pocket estuaries along the shoreline.

Basin Water Quality Evaluation

Limited data are available for evaluating major trends in water quality in the Doe Bay watershed. The only known source of data is:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project:** The Doe Bay watershed was monitored during 2006–2008 at the following location:
    - Site D8 – Unnamed Creek at Point Lawrence Road near the intersection with Homestead Road[2]

In situ Parameters

Results from 2006–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, and pH levels in the creek at Point Lawrence Road have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Bacteria

Bacteria data collected during the 2006–2008 FHLSOP monitoring effort indicate that fecal coliform levels in the creek at Point Lawrence Road have not met criteria for the freshwater primary contact recreation beneficial use, with annual geometric mean values >100 CFU/100 mL and multiple counts (32 percent, or 7 of 22 samples across 3 years) >200 CFU/100 mL.

Nutrients

Results from 2006–2008 FHLSOP monitoring indicate that while nitrate concentrations in the creek at Point Lawrence Road have consistently met the guidelines (≤1 mg/L) adopted by SJICD, ortho-phosphorus concentrations have not consistently met guidelines (≤0.1 mg/L), with average annual values ranging 0.07–0.21 mg/L.

Risk Summary and Management Recommendations

The Doe Bay watershed includes significant park area as well as residential, forestry and agriculture uses. It has 10.1 miles of streams (none fish bearing) and 3 percent of the watershed is freshwater wetlands. There are no lakes over 20 acres but there are numerous smaller lakes and ponds. Thirteen percent of the watershed is within an aquifer recharge area. There are numerous small pocket estuaries along the shore as well as patchy eelgrass and kelp beds. Limited water quality sampling has indicated elevated bacteria and ortho-phosphorus in Doe Bay Creek. There are stormwater problem reports of inadequate ditch capacity during heavy rains. Existing impervious cover is 1.5 percent and is estimated to increase to 7.4 percent at buildout. Given that there are few known flooding or water quality problems in the watershed and only modest increases in impervious surfaces are expected under full buildout conditions, we recommend that this watershed should continue to have water quality monitoring but overall it is a lower priority for further study and stormwater management.

[2] Approximate location determined using Google Earth.

East Sound

Land Use

The existing land use in the East Sound watershed is a mix of parks, single-family residential, undeveloped lands over 5 acres in size, and designated forest land with conservation easements (see Table 31).

Table 31. Existing Land Use in East Sound Watershed.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	3,927	29%
Manufacturing	8	0%
Residential	4,429	33%
Resource production and extraction	1,891	14%
Services	83	1%
Transportation, communication and utilities	89	1%
Undeveloped land and water areas	3,117	23%
Wholesale or retail trade	16	0%
Total	**13,562**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 13,562 acres in size and is in the central portion of Orcas Island, and is the largest watershed on the Island and in this study. The watershed flows to the south, east, and west into East Sound, and consists of eleven main drainage basins with defined outlets into the receiving water; see Figure 56. There is a total elevation drop of about 2,400 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Dolphin Bay Road, Orcas Road, Crescent Beach Road, Olga Road, Palisades Drive, and Point Lawrence Road.

Martin Lake - Basin 1 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 57. There is a total elevation drop of about 1,100 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow collects in Martin Lake and flows north and east about 5,000 feet in a stream course before entering the East Sound.

Ayer Lake - Basin 2 of the watershed is several hundred acres in size and is located in the SW bottom portion of the watershed; see Figure 58. There is a total elevation drop of about 1,100 feet across this basin. The basin is characterized by steep slopes in the upper portion and moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow collects into Ayer Lake and crosses Dolphin

Bay Road with a 24-inch and 12-inch culvert and flows to the north to combine with several wetland areas that eventually cross Dolphin Bay road with a 36-inch culvert and then continue east about 1,500 feet before entering East Sound.

Fowlers Pond - Basin 3 of the watershed is approximately 1,000 acres in size and is located in the northwest portion of the watershed; see Figure 59. There is a total elevation drop of about 1,400 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper and middle portions that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas north of the Gravel Pit that collect into fowlers Pond and cross Orcas road with a 36-inch culvert and then continues northeast about 1,500 feet in a stream before entering the Judd Cove in East Sound.

Eastsound Village - Basin 4 of the watershed is approximately 100 acres in size and is located in the northern portion of the watershed; see Figure 60. There is a total elevation drop of about 50 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland areas north of Main Street and combines with the Eastsound storm drain system with a 54-inch outfall to Fishing Bay in East Sound.

Crescent Beach - Basin 5 of the watershed is approximately 200 acres in size and is located in the northern portion of the watershed; see Figure 61. There is a total elevation drop of about 100 feet across this basin. The basin is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland areas north of Crescent Beach Road and crosses Crescent Beach Road with a 12-inch culvert about 100 feet before entering the Bay.

Ship Bay - Basin 6 of the watershed is several hundred acres in size and is located in the northeast portion of the watershed; see Figure 62. There is a total elevation drop of about 1,400 feet across this basin. The basin is characterized by very steep slopes in the upper portion, up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow collects into a pond located east of Olga Road and crosses the County road with a 24-inch culvert and continues to flow southwest about 600 feet before entering East Sound in a 30-inch outfall pipe.

Purdue Lake - Basin 7 of the watershed is approximately 600 acres in size and is located in the northeastern portion of the watershed; see Figure 63. There is a total elevation drop of about 2,000 feet across this basin. The basin is characterized by very steep slopes in the upper portion, up to about 10 percent in the middle portion and toward the bottom. The basin flow connects several wetland and pond areas in the upper basin that flow into Purdue Lake and then follows a stream course about 1 mile to the west and cross Olga Road with a 30-inch culvert 200 feet before entering the east Sound at Coon Hollow.

Youngren's Pond - Basin 8 of the watershed is approximately 400 acres in size and is located in the eastern portion of the watershed; see Figure 64. There is a total elevation drop of about 2,000 feet across this basin. The basin is characterized by very steep slopes in the upper portion, up to about 10 percent in the middle portion, which steepen toward the shoreline. The basin flow collects into Youngren's Pond and crosses Olga Road with two

24-inch culverts and an 18-inch culvert 200 feet before entering East Sound. This pond is used as a salmon hatchery.

Cascade Lake - Basin 9 of the watershed is approximately 2,500 acres in size and is located in the eastern portion of the watershed; see Figure 65. There is a total elevation drop of about 300 feet across this basin. The basin is characterized by steep slopes in the upper portion, moderate slopes up to about 10 percent in the middle and lower portions. The basin flow collects into Cascade Lake from Moran State Park to the north and Otters Pond from the west and crosses Palisades Road with a 40-inch culvert at the dam, and then continues in a steep stream 1,000 feet before entering East Sound at Cascade Bay.

Mountain Lake - Basin 10 of the watershed is nearly 4,000 acres in size and is located in the southeastern portion of the watershed; see Figure 66. There is a total elevation drop of about 2,400 feet across this basin. The basin is characterized by very steep slopes in the upper portion up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow collects into Mountain Lake from Moran State Park and continues south in Cascade Creek crossing Olga road with a bridge and continuing south through several wetland and pond areas. It then crosses Olga Road with a 72-inch and 48-inch culvert and travels another 1,500 feet south to cross under Point Lawrence Road with a bridge at the entry to Buck Bay, near Olga.

Obstruction Pass Road - Basin 11 of the watershed is several hundred acres in size and is located in the southeast portion of the watershed; see Figure 67. There is a total elevation drop of about 1,000 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper and middle portions that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas north of Point Lawrence Road and crosses the road with a 24-inch culvert. It then continues to flow south and west through wetlands, crosses Obstruction Pass Road with a 48-inch culvert and then continues west about 2,000 feet before crossing E.J. Young Road with a 36-inch culvert and entering East Sound.

Critical Resources

Aquatic resources in the watershed are summarized in Table 32.

Table 32. Summary of Aquatic Resources in East Sound Watershed.

Freshwater Wetlands	868 acres (6%)
Tidal Wetlands	0.3 acres (less than 0.1%)
Streams	28.4 miles (7.7 miles fish-bearing)
Significant Lakes	Cascade Lake (172 acres) Martin Lake (22 acres) Mountain Lake (198 acres)
Aquifer recharge areas	732 acres (5%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Ship Bay contains suitable habitat for various clam and crab species. The shorelines support kelp and eelgrass. Kelp is generally associated with rocky seep shorelines and eelgrass in the shallower pocket estuaries, primarily near Crescent Beach and the town of Olga.

Wetland, Aquatic, and Riparian

There are two lagoon/wetland systems at the head of East Sound, and a pocket estuary with tidal wetland in Buck Bay. There are several streams including four that potentially support salmon or trout. Critical aquifer recharge areas present along Olga Road between Cascade Lake and the town of Olga, Olga Cemetery Road, near Coon Hollow along Olga Road, and near Gravel Pit Road on the west side of the watershed. Smaller areas are mapped near Crescent Beach Drive, Lover's Lane, and Dolphin Bay Road near Elsie Road.

Threatened, Endangered, and Species of Local Concern

Fishing Bay and Ship Bay are important Herring spawning areas. A documented smelt spawning area is located adjacent to the town of Olga near Olga Park Lane. Coho salmon have been documented in the lower reach of the stream entering East Sound near Griffin Rocks from the small wetlands east of Olga Road. Coho are potentially present in Cascade Creek entering Buck Bay from Cascade Lake. Cascade Creek also supports coastal cutthroat trout. The large stream that feeds Grindstone Harbor and the stream that drains to Judd Cove both have been documented to sustain fish. The small stream entering East Sound from Martin Lake and running approximately parallel with Beatrice Lane supports coastal cutthroat trout. Bald eagles have been observed using shoreline habitat between the Town of Olga and Obstruction Pass. The rocky headlands common in the watershed are suitable habitat for rockfish.

Basin Water Quality Evaluation

Non-point source runoff in the East Sound watershed has been a water quality concern for several years. The San Juan County Watershed Management Action Plan, developed between 1997 and 1999, listed polluted stormwater runoff as a "high priority risk" for Eastsound, along with Friday Harbor and False Bay (San Juan County 1999).

The following information sources were reviewed to evaluate major trends in water quality in the East Sound watershed:

- **303(d) Listing Status**
- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The East Sound watershed was monitored during 2006–2008 at the following locations:
    - Site ES5 – Eastsound Village main stormwater outfall
    - Site BB7a – unnamed creek (Tributary to East Bay/Buck Bay) at Obstruction Pass Road
- **San Juan County Pilot Stormwater Monitoring Program** –
    - Year 1 data are available for the following locations in the East Sound watershed:

- Site O-E1 – Eastsound Village main stormwater outfall
- Site O-E3 – Constructed wetland, eastern inlet
- Site O-E4 – Constructed wetland, outlet
- Site O-E5 – Eagle Creek bridge culvert outfall
- Site O-E6 – Cascade Creek near Rosario at Cascade Harbor Inn
- Site O-E8 – Olga Road outfall at culvert

o During Year 2 of the pilot monitoring effort, the following additional sites are being sampled:

- Site O-E2-M – North East Sound/Indian Island
- Site O-E7 – Rosario Resort outfall immediately northwest of dock
- Site O-E9-M – East Sound point halfway between Indian Island and dock on Madrona Point
- Site O-E10-M – East Sound point halfway between Madrona Point and Raccoon Point
- Site O-E11-M – East Sound point 0.5 km south east of Rosario Point

- **DOH Receiving Water Coliform Monitoring**

In situ Parameters

Results from 2006–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, and pH levels at the Eastsound Village main stormwater outfall have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration. Additional data are needed to characterize current conditions for dissolved oxygen and pH at this site and the other San Juan County pilot monitoring sites in the East Sound watershed, as the majority of the 2012-2013 in situ data were flagged for quality assurance review issues (Stillwater Sciences 2014).

The unnamed creek (Tributary to East Bay/Buck Bay) is included on the 303(d) list as a water of concern (Category 2) with respect to dissolved oxygen (Listing 12334), based on data reported in 1999. For Category 2 waters, there is some evidence of a water quality problem, but not enough for Ecology to require a water quality improvement project at this time. Turbidity at the 2012-2013 pilot sites was variable but generally below 50 NTU (Stillwater Sciences 2014).

The East Sound waterbody is included on the 303(d) list as a Category 5 waterbody impaired for dissolved oxygen (Listing 10101). East Sound is also included on the 303(d) list as a water of concern (Category 2) regarding pH (Listing 10102).

Bacteria

The Unnamed Creek (Tributary to East Bay/Buck Bay) is included on the 303(d) list as a Category 5 waterbody impaired for bacteria (Listing 12335), based on data reported in 1999. Category 5 waterbodies require development and implementation of a TMDL. In addition, bacteria data collected during the 2006–2008 FHLSOP and the 2012–2013 SJC pilot stormwater monitoring effort indicate that levels of fecal coliform are generally elevated at the Eastsound Village main stormwater outfall (Site O-E1) and the Olga Road outfall (Site O-E8). Fecal coliform counts at these locations were greater than 200 CFU/100 mL on multiple occasions, such that bacteria levels exceed the primary contact recreation beneficial use criteria when calculated on a site-by-site basis or for the focus area as a whole. Fecal coliform counts at the other East Sound monitoring sites (O-E3, O-E4, O-E5, O-E6) were an order of magnitude lower than those at the Eastsound Village and Olga Road outfalls (Stillwater Sciences 2014) and met the criteria for primary contact recreation.

When compared across all six pilot study focus areas, the East Sound watershed is among those focus areas (along with Mud Bay and Fisherman Bay) that exhibit relatively higher fecal coliform and *E. coli* levels for 2012-2013, with the higher overall counts driven by contaminated discharges from the Eastsound Village and Olga Road outfalls (Table 4). Additional data collected during years 2 and 3 should allow for more a definitive comparison between focus areas and may allow for identification of specific sources of bacteria within each focal area.

Based on bimonthly data collected by the DOH, fecal coliform in East Sound ranged from 1.7 to 23 CFU/100 mL from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses. Therefore, although fecal coliform levels in freshwater conveyances in the East Sound watershed appear to be elevated, particularly at the Eastsound and Olga Road stormwater outfalls, levels in local receiving waters meet standards. Accordingly, the 303(d) listing status for East Sound indicates that receiving waters meet tested standards for clean waters with respect to bacteria (Listing 45815).

Nutrients

Results from 2006–2008 FHLSOP monitoring indicate that while nitrate concentrations at the Eastsound Village main stormwater outfall and the Unnamed Creek site have consistently met guidelines adopted by the SJICD (≤1 mg/L), ortho-phosphorus concentrations have not consistently met guidelines (< 0.1 mg/L), with average annual values ranging from 0.09 to 0.17 mg/L. During the 2012-2013 SJC pilot stormwater monitoring effort, nutrient concentrations at the village outfall and the other four East Sound watershed monitoring sites were variable by site and by storm event, with higher values tending to occur at the three sites in Eastsound Village (Stillwater Sciences 2014). Compared with values measured in the other five San Juan County focus areas (Table 3), values measured in Puget Sound Phase 3 monitoring (Ecology and King County 2011), and three national databases of monitored stormwater concentrations (Stillwater 2014), nutrients at East Sound monitoring sites were moderate but highly variable (nitrate + nitrite nitrogen 0.04–1.8 mg/L; ammonium

nitrogen 0.03–0.4 mg/L; organic nitrogen 0.1–2.1 mg/L; total nitrogen 0.3–2.7 mg/L; ortho-phosphorus <0.001–0.9 mg/L; total phosphorus <0.01–1.1 mg/L) (Stillwater Sciences 2014).

Metals

During 2012–2013, metals were relatively low at the five East Sound monitoring sites (arsenic <1–3.6 ug/L; cadmium <0.25 ug/L; copper <2–13 ug/L; lead 0.25–0.6 ug/L; zinc <0.5–4 ug/L) compared with reported values for typical urban stormwater runoff and Puget Sound Puget Sound Phase 3 monitoring (Ecology and King County 2011). All dissolved metals were below available Ecology hardness-based acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in East Sound watershed stormwater with respect to metals. Since hardness was only collected during the April 5, 2013 storm event, however, additional data are needed to confirm this result (Stillwater Sciences 2014).

TPHs and Herbicides/Pesticides

Measured concentrations of TPHs (benzene, toluene, ethyl-benzene, total xylenes, and gasoline [C8-C12]) were below the analytical detection limits (0.4–100 ug/L) during 2012-2013 San Juan County pilot stormwater monitoring. Herbicides/pesticides commonly used in San Juan County, including permethrin, MGK-264, and glyphosate, were below the analytical detection limits (0.1–10 ug/L) at East Sound watershed pilot monitoring sites during 2012-2013.

Surfactants

Anionic surfactants measured at East Sound watershed sites during 2012-2013 (0.15-0.75 ug/L) were similar to previous measurements reported for multiple sites across the San Juan Islands (i.e., range = 0.17-1.3 ug/L, mean = 0.57 ug/L; Barsh et al. 2008) and are far below the available USEPA criterion 1 for drinking water sources (500 ug/L).

Risk Summary and Management Recommendations

The East Sound watershed is the largest in the County and has a varied mix of land uses including parks and other protected lands, residential housing, forestry, and agriculture. The watershed has 28.4 miles of streams and 7.7 miles are fish bearing. Freshwater wetlands comprise 6 percent of the watershed. There are three lakes over 20 acres and numerous small lakes and ponds. Water quality problems in the watershed include elevated bacteria, low dissolved oxygen, and potentially some nutrients. Eastsound (the village) was the most highly reported site for stormwater problems and issues reported include erosion, ponding, flooding, and property damage. The majority of these reports are for locations in Eastsound but some apply to other areas such as the Rosario neighborhood. Existing impervious surface is 2.4 percent and is estimated to increase to 7.8 percent at buildout. Based on the expected increase in impervious surfaces from future development, the ongoing water quality concerns, and the significant flooding problems within this watershed, we recommend this watershed be a priority for improved stormwater management. In addition, the CSWAC prioritized this watershed for further study in connection with Volume 2 of this report to identify appropriate stormwater management strategies.

Guthrie and Grindstone Coves

Land Use

The existing land use in Guthrie and Grindstone Coves is mostly a mix of single-family residential and designated forest land, and some undeveloped lands over 5 acres in size (see Table 33).

Table 33. Existing Land Use in Guthrie and Grindstone Coves.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	153	5%
Manufacturing	0	0%
Residential	1,437	44%
Resource production and extraction	1,064	32%
Services	15	0%
Transportation, communication and utilities	0	0%
Undeveloped land and water areas	606	18%
Wholesale or retail trade	0	0%
Total	**3,274**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 3,274 acres in size and is in the southwestern portion of Orcas Island. The watershed generally flows to the south into Guthrie and Grindstone Coves, and consists of four main drainage basins with defined outlets into the receiving water; see Figure 68. There is a total elevation drop of about 1,100 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Killebrew Lake Road, Grindstone Harbor Road, and Guthrie Cove Road.

Victorian Valley - Basin 1 of the watershed is approximately 1,200 acres in size and is located in the western portion of the watershed; see Figure 69. There is a total elevation drop of about 1,100 feet across this basin. The basin is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetlands and ponds in the Victorian Valley area north of Laporte Road and Johnny Jones Road and crosses Killebrew Lake Road and continues in a stream about 3,000 feet before entering Harney Channel at Bayhead Marina.

Killebrew Lake - Basin 2 of the watershed is approximately 1,000 acres in size and is located in the central portion of the watershed; see Figure 70. There is a total elevation drop of about 1,000 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland areas east of Dolphin

Bay Road and crosses the road with a 24-inch culvert that flows into Killebrew Lake. The lake flow outlets to the south with a 48-inch culvert under Killebrew Lake Road. This flow continues in a stream about 2,400 feet to the south and finally crosses Grindstone Harbor Private Road with a 24-inch culvert about 200 feet before entering Grindstone Harbor.

Guthrie Cove - Basin 3 of the watershed is approximately 500 acres in size and is located in the eastern portion of the watershed; see Figure 71. There is a total elevation drop of about 900 feet across this basin. The basin is characterized by steep slopes in the upper portion, moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland areas south of white Beach Road and continues south, crossing Guthrie Cove Road in a 12-inch culvert and then continues west about 2,000 feet before entering Guthrie Cove.

Critical Resources

Aquatic resources in the watershed are summarized in Table 34.

Table 34. Summary of Aquatic Resources in Guthrie and Grindstone Coves Watershed.

Freshwater Wetlands	171 acres (5%)
Tidal Wetlands	0 acres (0%)
Streams	10.0 miles (1.3 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	51 acres (2%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The nearshore and marine resources in this watershed are somewhat limited compared to other watersheds. Suitable habitat for shellfish and forage fish spawning beaches are generally absent, although there are several pocket estuaries that could provide important habitat for migrating fish and other species. Significant estuaries include those at Chestnut Lane, Grindstone Harbor, and adjacent to Killebrew Lake Road near Bay Head Marina.

Wetland, Aquatic, and Riparian

Streams including the stream draining from Killebrew Lake, and the stream that drains from nearby wetlands and enters the pocket estuary at Bay Head Marina, potentially support trout. The discharge from these streams also likely support salmon species in the nearshore estuaries and contribute to the suitability of habitat there for migrating salmon. Killebrew Lake and other wetlands and streams in the management exhibit relatively intact habitat conditions and vegetated buffers. There is a critical aquifer recharge area near John Jones Road and Laporte Road.

Threatened, Endangered, and Species of Local Concern

Species present include kelp and eelgrass. The pocket beaches generally contain relative dense areas of eelgrass. A patchy distribution of kelp is documented along some of the outer shorelines adjacent to the pocket beaches.

Basin Water Quality Evaluation

Limited data are available for evaluating major trends in water quality in the Guthrie and Grindstone Coves watershed. The only known source of data is:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The Guthrie and Grindstone Coves watershed was monitored during 2006–2008 at the following location:
    - Site HC1 – Unnamed creek near Willow Creek Lane

In situ Parameters

Results from 2006–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, and pH levels at the unnamed creek downstream of Grant Dam have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Bacteria

Bacteria data collected during the 2006–2008 FHLSOP indicate that fecal coliform levels in the unnamed creek downstream of Grant Dam have met criteria for the primary contact recreation beneficial use, with annual geometric mean values consistently <100 CFU/100 mL. One instantaneous count (1 of 15 samples, or 7 percent) at this location was greater than 200 CFU/100 mL during the monitoring period.

Nutrients

Results from 2006–2008 FHLSOP monitoring indicate that nitrate and ortho-phosphorus concentrations at the unnamed creek downstream of Grant Dam site have consistently met guidelines adopted by SJICD (nitrate ≤1 mg/L; ortho-phosphorus ≤0.1 mg/L).

Risk Summary and Management Recommendations

This watershed currently has 1.7 percent impervious cover and it is estimated to increase to 11.4 percent at buildout (Table 2). Dominant land uses are residential and forestry. Water quality data are relatively limited but do not indicate any serious reason for concern. There are three stormwater problem reports of ponding and flooding near Killebrew Lake Road. Although impervious area is expected to increase substantially, we do not feel watershed conditions at this time warrant that this watershed be a priority for further study and stormwater management.

North Shore

Land Use

The existing land use in North Shore is mainly a mix of single-family residential, and resorts and group camps. Other uses include undeveloped residential on lands less than 5 acres in size and aircraft transportation (see Table 35).

Table 35. Existing Land Use in North Shore.		
Generalized Land Use Category	**Acres**	**Percentage of Total Basin**
Cultural, entertainment and recreational	251	21%
Manufacturing	4	0%
Residential	561	47%
Resource production and extraction	51	4%
Services	54	5%
Transportation, communication and utilities	117	10%
Undeveloped land and water areas	141	12%
Wholesale or retail trade	2	0%
Total	**1,182**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,182 acres in size and is in the northern portion of Orcas Island. The watershed generally flows to the south into the North Shore, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 72. There is a total elevation drop of about 500 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Mount Baker Road, Lover's Lane, and Sunset Avenue.

Airport - Basin 1 of the watershed is several hundred acres in size and is located in the western portion of the watershed; see Figure 73. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 2 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and areas north of Enchanted Forest Road and crosses Lover's Lane with an 18-inch culvert and then flows north and crosses Mount Baker Road with a 24-inch culvert. Flow then continues north about 4,000 feet in the Airport storm drain system before entering the Bay with a 24-inch outfall at the north end of the runway and an 18-inch culvert at the Brandt's Landing Marina, which are both fitted with tide gates, due to low elevations.

North Beach - Basin 2 of the watershed is approximately 100 acres in size and is located in the northeastern portion of the watershed; see Figure 74. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow collects runoff from a residential area and flows to the north in a ditch and 18-inch pipe system to a 24-inch outfall at the North Beach Road end. Residences are located in close proximity to the shoreline outfall.

Critical Resources

Aquatic resources in the watershed are summarized in Table 36.

Table 36. Summary of Aquatic Resources in North Shore Orcas Watershed.	
Freshwater Wetlands	107 acres (9%)
Tidal Wetlands	0 acres (0%)
Streams	2.3 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	688 acres (56%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The North Shore Watershed marine shoreline supports a relatively continuous patch of eelgrass and habitat for a variety of subtidal clams and sea urchin. There is a large marsh complex at the southeast end of Terrill Beach that exhibits conditions of tidal estuary, somewhat rare in the County, and important for numerous species.

Wetland, Aquatic, and Riparian

The largest wetlands are in the central part of the watershed adjacent to the airport runway and along Lover's Lane, although small patches are mapped throughout the watershed. Streams are somewhat limited in the watershed and comprise small ephemeral streams associated with the wetlands and ditches. Over half of the watershed (56 percent) is mapped as critical aquifer recharge area. These areas are located generally east of North Beach Road and west of Lover's Lane.

Threatened, Endangered, and Species of Local Concern

Chinook and other salmonid species are likely to occur in the nearshore area along an important migration route into President Channel. Bald eagles have been observed along the shoreline. Other important species present include eelgrass, clams, and sea urchin.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the North Shore watershed.

Risk Summary and Management Recommendations

The North Shore watershed currently has 10.4 percent impervious cover and it is estimated to increase to 17.6 percent at buildout (Table 2). Residential development, resorts and camps dominate land uses. There are no water quality data available. There are a number of stormwater problem reports of ponding, flooding, and erosion in this watershed. Given that part of Eastsound is within this watershed and stormwater issues in Eastsound are well documented, we recommend that this watershed receive further study and improved stormwater management coordinated with measures taken in the rest of Eastsound.

President Channel

Land Use

The existing land use in President Channel is a mix of single-family residential, designated forest land, undeveloped lands with conservation easements, undeveloped lands over 5 acres in size, and resorts and group camps (see Table 37).

Table 37. Existing Land Use in President Channel.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	239	8%
Manufacturing	0	0%
Residential	1,095	39%
Resource production and extraction	750	26%
Services	2	0%
Transportation, communication and utilities	3	0%
Undeveloped land and water areas	745	26%
Wholesale or retail trade	0	0%
Total	**2,836**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 2,836 acres in size and is in the northwestern portion of Orcas Island. The watershed generally flows to the northwest into President Channel, and consists of one main drainage basin with a defined outlet into the receiving water; see Figure 75. There is a total elevation drop of about 1,100 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including West Beach Road, and Enchanted Forest Road.

West Beach - Basin 1 of the watershed is approximately 1,000 acres in size and is located in the southern portion of the watershed; see Figure 76. There is a total elevation drop of about 1,100 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 2 percent toward the bottom. The basin flow connects several wetland areas south of West Beach Road and crosses West Beach Road with a 30-inch culvert and then continues flowing north in a stream about 200 feet before crossing West Beach Road again but with a 60-inch culvert and flow continues about 1,000 feet before entering the Bay at West Beach.

Critical Resources

Aquatic resources in the watershed are summarized in Table 38.

Table 38. Summary of Aquatic Resources in President Channel Watershed.	
Freshwater Wetlands	105 acres (4%)
Tidal Wetlands	0 acres (0%)
Streams	6.1 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	307 acres (11%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

There is a documented smelt spawning beach north of Cedar Hill Road. Other beaches along the marine shoreline may also support forage fish spawning. The shoreline is also suitable habitat used by red sea urchin. The nearshore area has been identified as an important migration route for juvenile salmon as indicated by high densities in the nearshore along President Channel (Beamer et al. 2008; Wyllie-Echeverria and Barsh 2007). Pocket beaches that support continues patches of eelgrass are near Old Pottery Road, Waterfront Way, Beach Haven Road, and Cedar Hill Road.

Wetland, Aquatic, and Riparian

Wetlands in the watershed are present in a patchy distribution primarily north of West Beach Road. Many of the wetlands are in agricultural fields or have disturbed buffers, such as the wetlands along West Beach Road and Cadden Lane, and near Darvill Farm Road. Streams within the watershed are perennial or ephemeral and do not likely support salmon or trout except that the discharge from these streams into the nearshore areas of President Channel could be important for salmon that use this area as a key migration route. Part of the large critical aquifer area located in the North Shore watershed also extends into the northern part of the President Channel watershed. It is primarily located around Cedar Hill Road, but smaller areas are also mapped between Enchanted Forest Road and West Beach Road.

Threatened, Endangered, and Species of Local Concern

Species present include numerous salmon species in the nearshore area and sea urchin. Bald eagles have been observed along the shoreline primarily north of Enchanted Forest Road and between President Channel Lane and Cormorant Bay Road. A patchy distribution of kelp is along most of the shoreline and areas of dense eelgrass along the pocket beaches.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the President Channel watershed.

Risk Summary and Management Recommendations

The President Channel watershed currently has 1.6 percent impervious cover and it is estimated to increase to 10.6 percent at buildout (Table 2). Residential development, forestry, and agriculture dominate land uses. There are no water quality data available. There is one report of flooding in the stormwater report (Appendix C). Although impervious

area is expected to increase substantially, we do not feel watershed conditions at this time warrant that this watershed be a priority for further study and stormwater management.

Raccoon Point

Land Use

The existing land use in Raccoon Point is mostly a mix of single-family residential, undeveloped lands over 5 acres in size and parks (see Table 39).

Table 39. Existing Land Use in Raccoon Point.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	870	28%
Manufacturing	0	0%
Residential	1,176	38%
Resource production and extraction	113	4%
Services	0	0%
Transportation, communication and utilities	37	1%
Undeveloped land and water areas	937	30%
Wholesale or retail trade	0	0%
Total	**3,133**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 3,133 acres in size and is in the northeastern portion of Orcas Island. The watershed generally flows to the northeast into Georgia Strait, and consists of two main drainage basins with a defined outlet into the receiving water; see Figure 77. There is a total elevation drop of about 1,450 feet across the watershed. The watershed is characterized by steep slopes in the upper, middle, and lower portions. The watershed flow crosses several county roads in culverts including private roads, Raccoon Point Road, Day Lake Road, and Key Drive.

Day Lake - Basin 1 of the watershed is several hundred acres in size and is located in the northern portion of the watershed; see Figure 78. There is a total elevation drop of about 1,450 feet across this basin. The basin is characterized by steep slopes in the upper, middle, and lower portions. The basin flow collects into Day Lake in the Buck Mountain area with an outlet to the east. Flow then continues northeast about 2,500 feet down a steep sloped stream course, crossing Raccoon Point Road with a 12-inch and a 24-inch culvert about 800 feet before entering Georgia Strait. A second outlet to Day Lake flows about 1,000 feet down a steep sloped stream course, crossing Raccoon Point Road with an unknown size culvert and finally crossing Key Drive with two 12-inch culverts about 800 feet before entering Georgia Strait. Residences are located in close proximity to the shoreline outfall.

Terrill Beach Road - Basin 2 of the watershed is approximately 600 acres in size and is located in the northern portion of the watershed; see Figure 79. There is a total elevation drop of

about 950 feet across this basin. The basin is characterized by steep slopes in the upper portion, and flattens to 2 percent to 5 percent in the middle and lower portions. The basin flow begins on the north side of Buck Mountain flowing to the northwest into a wetland. The flow then crosses Terrill Beach Road in a 24-inch culvert and combines with flows that cross Mount Baker road with three 12-inch culverts, continuing to the north through wetlands and pond areas, finally crossing Bartel Road with two 24-inch culverts about 500 feet before entering President Channel. Residences are located in close proximity to the shoreline outfall.

Critical Resources

Aquatic resources in the watershed are summarized in Table 40.

Table 40. Summary of Aquatic Resources in Raccoon Point Watershed.

Freshwater Wetlands	110 acres (3%)
Tidal Wetlands	1.7 acres (0.1%)
Streams	7.0 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer recharge areas	349 acres (11%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

There are several potential tidal wetlands along the shoreline. Of particular importance due to the habitat it provides and overall rarity in the watershed is one located immediately west of Matia View Drive near the northern extent of the watershed. The shoreline supports patchy to continuous kelp population.

Wetland, Aquatic, and Riparian

Wetlands are primarily in the northwestern portion of the watershed. Some are have buffers disturbed by agriculture or tree removal, but others have intact vegetated buffers. There are also wetlands associated with Day Lake and Twin Lakes in the central portion of the watershed. The small streams in the watershed do not likely support salmon or trout. The critical aquifer recharge areas mapped in the watershed are concentrated around Terrill Beach Road and Buckhorn Road, as well as the mostly forested area adjacent to the North Shore watershed.

Threatened, Endangered, and Species of Local Concern

Species present include kelp and salmon in the nearshore. The shoreline contains suitable habitat for bald eagle perching and nesting, and eagles have been observed along most of the shoreline.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Raccoon Point watershed.

Risk Summary and Management Recommendations

The Raccoon Point watershed currently has 1.7 percent impervious cover and it is estimated to increase to 5.8 percent at buildout (Table 2). Residential development and parks dominate land uses. There are no water quality data available. There are reports of flooding in the watershed (Appendix C). Impervious area is not expected to increase sufficiently to degrade water resources in this watershed; therefore, we recommend that this watershed be a low priority for further study and stormwater management.

West Sound

Land Use

The existing land use in West Sound is mainly a mix of single-family residential and undeveloped lands with conservation easements. Other uses include designated forest land and agriculture (see Table 41).

Table 41. Existing Land Use in West Sound.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	111	2%
Manufacturing	0	0%
Residential	2,512	37%
Resource production and extraction	1,450	21%
Services	42	1%
Transportation, communication and utilities	12	0%
Undeveloped land and water areas	2,643	39%
Wholesale or retail trade	3	0%
Total	**6,772**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 6,772 acres in size and is in the southwestern portion of Orcas Island. The watershed generally flows to the south into West Sound, and consists of seven main drainage basins with defined outlets into the receiving water; see Figure 80. There is a total elevation drop of about 1,400 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Deer Harbor Road, Nordstrom Lane, Orcas Road, and Bob Schoen Road.

Lime Quarry Road - Basin 1 of the watershed is several hundred acres in size and is located in the western portion of the watershed; see Figure 81. There is a total elevation drop of about 1,400 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 2 percent toward the bottom. The basin flow connects several wetland areas north of Deer Harbor Road

in the Lime Quarry Road area and crosses Deer Harbor Road with a 30-inch culvert. Flow then continues about 800 feet in a stream course before entering Massacre Bay.

Wildrose Lane - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 82. There is a total elevation drop of about 1,200 feet across this basin. The basin is characterized by steep slopes in the upper, middle, and lower portions. The basin flow connects several steep stream courses and ponds and finally crosses Deer Harbor Road with a 24-inch culvert about 400 feet before entering Massacre Bay.

Ships Peak West - Basin 3 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 83. There is a total elevation drop of about 1400 feet across this basin. The basin is characterized by steep slopes in the upper, middle, and lower portions. The basin flow connects several steep stream courses, wetlands and ponds and finally crosses Deer Harbor Road with a 24-inch culvert about 40 feet before entering Massacre Bay.

West Sound Creek - Basin 4 of the watershed is approximately 4,000 acres in size and is located in the central portion of the watershed; see Figure 84. There is a total elevation drop of about 1,450 feet across this basin. The basin is characterized by steep slopes in the upper portion, moderate slopes up to about 10 percent in the middle portion that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas in the Crow Valley area with flows from the north side of Mount Woolard and eastern valley flow from as far north as Gravel Pit Road. The crow valley flows cross Nordstrom Lane with a 36-inch culvert and the Mount Woolard flows from the east cross Orcas Road with a 60-inch culvert. The combined flows travel south and cross Deer Harbor Road with a bridge at the shoreline, where it enters West Sound.

Pinneo Road - Basin 5 of the watershed is several hundred acres in size and is located in the eastern portion of the watershed; see Figure 85. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper and middle portions that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas east of Orcas Road and crosses Orcas Road with a 24-inch culvert and then continues west about 2,000 feet before crossing Bob Schoen Road in a 36-inch culvert and entering the West Sound.

Warm Valley - Basin 6 of the watershed is several hundred acres in size and is located in the southeast portion of the watershed; see Figure 86. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper and middle portions that flatten to about 5 percent toward the bottom. The basin flow connects several wetland and pond areas east of Orcas Road and cross the road with two 18-inch culverts and then continues west about 1,200 feet before entering West Sound.

Orcas Village - Basin 7 of the watershed is less than 50 acres in size and is located in the western portion of the watershed; see Figure 87. There is a total elevation drop of about 250 feet across this basin. The basin is characterized by moderate slopes up to about 10 percent in the upper and middle portions that steepen toward the shoreline. The basin

flow begins in the Orcas Hill Road area and flows south into the Orcas Ferry Landing storm drain system which outlets under the ferry-loading ramp in an 18-inch storm drain outfall.

Critical Resources

Aquatic resources in the watershed are summarized in Table 42.

Table 42. Summary of Aquatic Resources in West Sound Watershed.

Freshwater Wetlands	366 acres (5%)
Tidal Wetlands	1.1 acres (less than 0.1%)
Streams	21.9 miles (3.2 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	687 acres (10%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The West Sound watershed contains a dynamic marine shoreline with diverse habitats. There are several pocket estuaries including those adjacent to Deer Harbor Road near Payton Lane, near Warm Valley Lane, and at the north end of Massacre Bay. The estuaries contain eelgrass, while outer shorelines are characterized by kelp populations. West Sound has been identified as having priority spawning habitat area for forage fish. Sea birds commonly feed on forage fish, and are frequently observed among the many small islands near the shorelines of West Sound.

Wetland, Aquatic, and Riparian

The largest wetlands are in the central portion of the watershed and have been affected by agriculture. Smaller forested wetlands are scattered throughout the watershed. Nine small, mostly ephemeral, streams drain to the east side of West Sound. Besides these streams, there are number of other smaller ephemeral streams that generally drain to embayments throughout the watershed. Crow Valley Creek, which runs approximately parallel with Crow Valley Road provides habitat for coastal cutthroat trout and may support coho and chum salmon.

Threatened, Endangered, and Species of Local Concern

Important species present include Pacific herring and other forage fish, Dungeness crab, kelp, and eelgrass in the marine environment, as well as trout and potentially salmon in Crow Valley Creek. Bald eagles are documented primarily along the forested western shoreline of West Sound.

Basin Water Quality Evaluation

Limited data are available for evaluating trends in water quality in the West Sound watershed. Data from the following programs were reviewed:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The West Sound watershed was monitored during 2006–2008 at the following location:
    - Site WS3 – Unnamed creek between Boddington Lane and Payton Lane

In situ Parameters

Results from 2006–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, and pH levels at the unnamed creek at Boddington Lane have been generally supportive of Ecology's designated beneficial uses including for salmonid spawning, rearing, and migration.

Bacteria

Bacteria data collected during the 2006–2008 FHLSOP monitoring effort indicate that fecal coliform counts are relatively high at the sampling site. During 2006, fecal coliform levels in the unnamed creek at Boddington Lane did not meet criteria for the freshwater primary contact recreation beneficial use, with an annual geometric mean value of 185 CFU/100 mL. Fecal coliform geometric mean values decreased in 2007 and 2008 to <100 CFU/100 mL, but over the multi-year monitoring period multiple counts (5 of 22 samples, or 23 percent) still exceeded 200 CFU/100 mL.

Nutrients

Results from 2006–2008 FHLSOP monitoring indicate that while nitrate concentrations in unnamed creek at Boddington Lane met guidelines adopted by the SJICD (≤1 mg/L), ortho-phosphorus concentrations have not consistently met guidelines (≤0.1 mg/L), with average annual concentrations of 0.21-0.26 mg/L.

Risk Summary and Management Recommendations

The West Sound watershed is the third largest in the County. It currently has 2.2 percent impervious cover and it is estimated to increase to 12 percent at buildout (Table 2). Residential development, farming, and forestry dominate land uses. Water quality concerns include bacteria and ortho-phosphorus. There are reports of flooding and erosion in the watershed (Appendix C). This watershed has a number of instream ponds that may be adversely impacting stream hydrology by delaying and diminishing flow to West Sound. Since 3.2 miles of streams within this watershed are fish bearing, this may be affecting salmon spawning. We recommend that monitoring of this watershed continue as it has a rich shoreline ecosystem and numerous streams that discharge to West Sound. Additional stream monitoring would be useful to evaluate ongoing water quality issues and to establish a baseline for assessing whether degradation occurs in the future.

Lopez Island

Aleck Bay

Land Use

The existing land use in Aleck Bay is a mix of single-family residential, designated forest land, and open space (see Table 43).

Table 43. Existing Land Use in Aleck Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	0	0%
Manufacturing	0	0%
Residential	117	50%
Resource production and extraction	64	28%
Services	0	0%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	50	22%
Wholesale or retail trade	0	0%
Total	**232**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 232 acres in size and is in the southern portion of Lopez Island. The watershed generally flows to the south and east into Aleck Bay, and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 88. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to 1 percent near the shoreline. The watershed flow crosses no county roads in a culvert.

Hutten Lane - Basin 1 of the watershed is less than a hundred acres in size and is located in the central portion of the watershed; see Figure 89. There is a total elevation drop of about 150 feet across this basin. The basin flow begins at a gentle ridge from the south and flows north about 1000 feet into a wetland area near Hutten Lane, turning east the flow concentrates into a stream that flows about 800 feet into the Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 44.

Nearshore and Marine

The nearshore area is characterized by the steep bedrock shoreline and an extensive pocket beach at the head of the bay (west shoreline). Several smaller embayments are along the north and south shores of the bay.

Table 44. Summary of Aquatic Resources in Aleck Bay Watershed.	
Freshwater Wetlands	11 acres (5%)
Tidal Wetlands	0 acres (0%)
Streams	0.2 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	139 acres (60%)

Note: Significant lakes are greater than 20 acres.

Wetland, Aquatic, and Riparian

There is large, primarily emergent wetland extending from the back beach between Hutton Lane and Tralnes Road across the central portion of the watershed. The vegetative structure of the wetland and buffer are mainly intact, providing potential habitat for a variety of nearshore marine fish and birds. The wetland is associated with the single ephemeral stream in the watershed. The same area containing the stream and wetland is also mapped as a critical aquifer recharge area.

Threatened, Endangered, and Species of Local Concern

Aleck bay contains suitable habitat for sea urchin. There is a mixed community of kelp and eelgrass mapped throughout the shoreline.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Aleck Bay watershed.

Risk Summary and Management Recommendations

Existing impervious cover in the Aleck Bay watershed is relatively low (2.1 percent) compared to other watersheds in the County. It contains just one large emergent wetland and only 0.2 miles of streams. Under full buildout conditions, impervious surfaces are expected to increase to 12.4 percent (Table 2). However, there are currently no documented flooding problems in the watershed and no water quality data is available. Therefore, we recommend that this watershed be a lower priority for stormwater management.

Davis Bay

Land Use

The existing land use in Davis Bay is mostly a mix of agriculture and single-family residential with some undeveloped lands over 5 acres in size and open space farm conservation (see Table 45).

Stormwater Infrastructure

The watershed is approximately 5,054 acres in size, is in the south central portion of Lopez Island, and is the largest watershed on Lopez Island. The watershed generally flows to the south into Davis Bay, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 90. There is a total elevation drop of about 500 feet across the

watershed. The watershed is characterized gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including School Road, Center Road, Richardson Road, Dill Road, Fisherman Bay Road, Airport Road, and Davis Bay Road.

Table 45. Existing Land Use in Davis Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	7	0%
Manufacturing	0	0%
Residential	1,741	35%
Resource production and extraction	1,814	37%
Services	142	3%
Transportation, communication and utilities	29	1%
Undeveloped land and water areas	1,195	24%
Wholesale or retail trade	13	0%
Total	**4,940**	**100%**

Source: San Juan County (2013)

Airport - Basin 1 of the watershed is approximately 1,500 acres in size and is located in the southern portion of the watershed; see Figure 91. There is a total elevation drop of about 300 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas north of Dill Road and continues south crossing Fisherman Bay Road with a 72-inch culvert and then crosses Davis Bay Road with a 72-inch culvert. Flow then continues south about 0.8 miles to Davis Bay across a very gentle valley with wetland areas, crossing Davis Bay Road with a 60-inch culvert about 1,600 feet before entering the Bay at a pond along the shoreline.

Richardson Road - Basin 2 of the watershed is nearly 3,500 acres in size and is located in the eastern portion of the watershed; see Figure 92. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and lake areas at the base of Lopez Hill from the east and the School area from the north, crossing Center Road with a 24-inch culvert and crossing Davis Bay Road in several locations with smaller culverts. This flow combines with flows from the north and east and continues west where it crosses Center Road with a 48-inch culvert and continues south. It finally crosses Richardson Road with a 60-inch, 18-inch and two 12-inch culverts and then crosses flat wetland pasture about 3,000 feet before entering Mya Cove near Davis Head where there is a tide gate.

Critical Resources

Aquatic resources in the watershed are summarized in Table 46.

Table 46. Summary of Aquatic Resources in Davis Bay Watershed.	
Freshwater Wetlands	529 acres (10%)
Tidal Wetlands	0 acres (0%)
Streams	12.3 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	520 acres (10%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The watershed contain approximately 2.5 miles of marine shoreline along embayments surrounding Davis Bay. Marine habitat is suitable for sea urchin and likely for migrating salmon, like most areas throughout the county's nearshore. The nearshore support a mixed community of eelgrass and kelp in a patchy distribution. Mya Cove is an estuary typical of the type that can provide important transitional habitat for migrating fish.

Wetland, Aquatic, and Riparian

Drainage enters Mya Cove from the large wetland area west of Richardson Road. Other significant wetlands are near Airport Road and Fisherman Bay Road, and in a complex patchwork throughout the watershed. Most are located emergent wetlands located amidst agricultural fields without significant forest cover. Critical aquifer recharge areas are primarily in the southern portion of the watershed including along Burt Road and Shark Reef Road, and large areas surrounding the wetland that discharges to Mya Cove.

Threatened, Endangered, and Species of Local Concern

Species present include sea urchin, kelp, and eelgrass. Farther inland, the large wetland areas likely provide habitat for waterfowl.

Basin Water Quality Evaluation

Limited data are available for evaluating trends in water quality in the Davis Bay watershed. Data from the following programs were reviewed:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The Davis Bay watershed was monitored during 2004–2008 at the following location:
    - Site DB4 – Wooded gully on Davis Bay Road, just west of Rock "R" Drive

In situ Parameters

Results from 2004–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, pH levels, and turbidity at the Davis Bay watershed site have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Bacteria

Bacteria data collected during the 2004–2008 FHLSOP indicate that fecal coliform levels at the Davis Bay watershed site consistently met criteria for the primary contact recreation beneficial use , with annual geometric mean values consistently <50 CFU/100 mL and ≤10 percent of sample >200 CFU/100 mL during the monitoring period.

Nutrients

Results from 2004-2008 FHLSOP monitoring indicate ortho-phosphorus concentrations at the Davis Bay watershed site have not consistently met guidelines adopted by the SJICD (≤0.1 mg/L), while nitrate concentrations met the guidelines (≤1 mg/L) during 2006–2008 but not during 2004–2006.

Risk Summary and Management Recommendations

Agriculture and single-family residential are the dominate land uses in the Davis Bay watershed. Associated existing impervious cover represents only 2 percent of the watershed area. The watershed contains several large wetland areas and 12.3 miles of stream. Although there are few protected species present, Mya Cove likely provides important transitional habitat for migrating fish. Under full buildout conditions, impervious surfaces are expected to increase to 11.9 percent (Table 2). However, there are currently no documented flooding problems in the watershed and limited water quality sampling has indicated no concerns. Given these considerations, we recommend that this watershed be a lower priority for stormwater management at this time.

Fisherman Bay

Land Use

The existing land use in Fisherman Bay is mostly a mix of single-family residential and undeveloped lands over 5 acres in size with some undeveloped residential lands less than 5 acres in size (see Table 47).

Table 47. Existing Land Use in Fisherman Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	10	1%
Manufacturing	0	0%
Residential	945	66%
Resource production and extraction	113	8%
Services	31	2%
Transportation, communication and utilities	3	0%
Undeveloped land and water areas	323	22%
Wholesale or retail trade	13	1%
Total	**1,439**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,439 acres in size and is in the west central portion of Lopez Island. The watershed generally flows to the west into Fisherman Bay, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 93. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Fisherman Bay Road, and Hummel Lake Road.

Lopez Village - Basin 1 of the watershed is several hundred acres in size and is located in the northern portion of the watershed; see Figure 94. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas northeast of Fisherman Bay Road, crosses Fisherman Bay Road with a 24-inch culvert, and then connects into the Lopez Village storm drain system, which has a 36-inch outfall to the Fisherman Bay and a 12-inch outlet to the Weeks wetland area.

Hummel Lake Road - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 95. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas north and south of Hummel Lake Road, west of Center Road and cross Fisherman Bay Road with a 39-inch culvert about 600 feet before entering Fisherman Bay. This basin also includes an 18-inch culvert crossing of Fisherman Bay Road near Island Marine Center Marina.

Critical Resources

Aquatic resources in the watershed are summarized in Table 48.

Table 48. Summary of Aquatic Resources in Fisherman Bay Watershed.

Freshwater Wetlands	74 acres (5%)
Tidal Wetlands	33.9 acres (2.2%)
Streams	1.1 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	281 acres (18%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The Fisherman Bay watershed contains the large areas of tidal emergent wetlands compared to other watersheds. Tidal wetlands at Weeks Point at the north end of the Bay and along Tinkham Lane and Bayshore Road at the south end are susceptible to runoff from surrounding developed areas.

Wetland, Aquatic, and Riparian

The watershed contains several freshwater wetlands and associated stream that begin north of Hummel Lake Road and flow southwest to enter the bay. There are similar wetland areas near Sunset Lane and Redgate Lane, and along Weeks Road. A critical aquifer recharge area spans most of the length of the watershed from Hummel Lake Road extending southwest to Bayshore Road and Channel Road at Rock Point.

Threatened, Endangered, and Species of Local Concern

Eelgrass is present in a patchy distribution throughout the watershed's marine shoreline.

Basin Water Quality Evaluation

Data from the following water quality monitoring programs were reviewed to evaluate major trends in water quality in the Fisherman Bay watershed:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) - San Juan Islands Watershed Project**: The Fisherman Bay was monitored during 2004–2008 at the following locations:
  - Site FM2 – Culvert along Lopez Road, adjacent to Weeks Road
  - Site LV7 – Culvert in Lopez Village along Lopez Road that drains into Weeks Wetland
- **San Juan County Pilot Stormwater Monitoring Program**:
  - Year 1 data are available for the following locations in the Fisherman Bay watershed:
    - Site L-F1 – Lopez Road, north of village, west side of road, (36-inch) metal outfall
    - Site L-F3 – Lopez Village swale, storm drain outlet to Weeks Wetland
    - Site l-F4 – Weeks Wetland, northern edge at swale entrance
    - Site L-F5 – Fisherman Bay Road culvert outfall west of marina on west side of road
    - Site L-F6 – Fisherman Bay Road at culvert south of Islander Resort on east side of road
  - During Year 2 of the pilot monitoring effort, the following additional sites are being sampled:
    - Site L-F2– Old Post Road (48-inch) outfall on shoreline, downstream of CV9 weir
    - Site L-F7-M – Fisherman Bay (receiving water, receiving water sediments)

In situ Parameters

Results from 2004–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen, and pH levels at sites in the Fisherman Bay watershed are generally supportive of

Ecology designated beneficial uses including for salmonid spawning, rearing, and migration. During the 2012–2013 SJC pilot stormwater monitoring effort, dissolved oxygen was variable by storm event (5.2–11.5 mg/L) but was generally greater than the Ecology minimum freshwater numeric criterion of 8 mg/L for salmonid, spawning, rearing and migration designated beneficial uses (WAC-173-201A-200). The November 12, 2012 storm event was the exception, with dissolved oxygen concentrations below 7 mg/L (Stillwater 2014). Additional data are needed to characterize current conditions for dissolved oxygen and pH at the other San Juan County pilot monitoring sites in the Fisherman Bay watershed, as the majority of the 2012-2013 *in situ* data were flagged for quality assurance review issues (Stillwater Sciences 2014).

During 2004-2008, turbidity was variable and ranged 10 to 185 NTU. Turbidity data at the 2012-2013 pilot sites were variable but generally below 50 NTU (Stillwater Sciences 2014).

Bacteria

Data collected during the 2004–2008 FHLSOP monitoring effort indicate that sites along Lopez Road have consistently met criteria for freshwater primary contact recreation beneficial use with annual geometric mean values consistently <100 CFU/100 mL and only one sample (1 of 11 samples, or 9 percent) greater than 200 CFU/100 mL during the monitoring period. During 2012–2013, fecal coliform counts were variable by site and storm event. Instantaneous counts at the Lopez Road, Lopez Village, and Weeks Wetland outfalls (Sites L-F1, L-F3, L-F4) were all >200 CFU/100 mL on one occasion, indicating that bacteria levels are currently not meeting freshwater criteria. During the 2012–2013 monitoring efforts, fecal coliform counts at the other Fisherman Bay monitoring sites (L-F5, L-F6) were an order of magnitude lower than at the other sites (Stillwater Sciences 2014).

When compared across all six pilot study focus areas, Fisherman Bay is among those watersheds (along with Mud Bay and East Sound) that exhibit relatively higher fecal coliform and *E. coli* levels for 2012-2013 (Table 4), primarily driven by the conditions at the at Lopez Road, Lopez Village, and Weeks Wetland outfalls. Additional data collected during years 2 and 3 should allow for a more definitive comparison between focus areas and may allow for identification of specific sources of bacteria within each focal area.

Nutrients

For the 2004–2008 monitoring period, ortho-phosphorus concentrations in the Fisherman Bay watershed consistently exceeded guidelines (≤0.1 mg/L) adopted by the SJICD, while nitrate concentrations consistently met the guidelines (≤1 mg/L). During 2012–2013, nutrient concentrations at the five Fisherman Bay watershed sites were variable by site and by storm event (Stillwater Sciences 2014). Compared with values measured in the other five San Juan County focus areas, nutrients at Fisherman Bay monitoring sites are relatively high (nitrate + nitrite nitrogen <0.01–1.2 mg/L; ammonium nitrogen 0.1–0.4 mg/L; organic nitrogen 0.4–2.1 mg/L; total nitrogen 0.8–2.8 mg/L; ortho-phosphorus 0.02–0.11 mg/L; total phosphorus 0.07–0.4 mg/L) (Table 3). Total phosphorus concentrations at Fisherman Bay sites were high compared to Puget Sound Phase 3 monitoring (Ecology and King County 2011) and three national databases of monitored stormwater concentrations (Stillwater Sciences 2014). However, the high variability and low sample sizes preclude further evaluation of trends at this time (Stillwater Sciences 2014).

Metals

During 2012–2013, total metals were relatively low at the five Fisherman Bay monitoring sites (arsenic <1–4 ug/L; cadmium <1 ug/L; copper 3–70 ug/L; lead <0.5–7 ug/L; zinc 5–110 ug/L) compared with reported values for typical urban stormwater runoff and Puget Sound Puget Sound Phase 3 monitoring (Ecology and King County 2011). Sites L-F5 and L-F6 exhibited the highest levels of copper, lead, and zinc of any sites in the study. All dissolved metals were below available Ecology hardness-based acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in Fisherman Bay stormwater regarding metals. Since hardness was only collected during the April 5, 2013 storm event, additional data are needed to confirm this result (Stillwater Sciences 2014).

TPHS and Herbicides/Pesticides

Measured concentrations of TPHs (benzene, toluene, ethyl-benzene, total xylenes, and gasoline [C8-C12]) were below the analytical detection limits (0.4–100 ug/L) during 2012-2013 San Juan County pilot stormwater monitoring. Herbicides/pesticides commonly used in San Juan County, including permethrin, MGK-264, and glyphosate, were below the analytical detection limits (0.1–10 ug/L) at Fisherman Bay pilot monitoring sites during 2012-2013.

Surfactants

Anionic surfactants measured at Fisherman Bay sites during 2012-2013 (i.e., 0.13–0.6 ug/L) were similar to previous measurements reported for multiple sites across the San Juan Islands (i.e., range = 0.17–1.3 ug/L, mean = 0.57 ug/L; Barsh et al. 2008) and are far below the available USEPA criterion[1] for drinking water sources (500 ug/L).

Risk Summary and Management Recommendations

Land use in the Fisherman Bay watershed is predominantly residential with the associated existing impervious cover representing approximately 5.4 percent of the total watershed area. Nearshore areas of the watershed contain large areas of tidal emergent wetlands but there are only 1.1 miles of stream in the watershed. Under full buildout conditions, impervious surfaces are expected to increase to 11.1 percent (Table 2). Both flooding and water quality problems have been documented in this watershed. Relatively high concentrations of fecal coliform and E. Coli have been measured in the watershed under existing conditions. Therefore, we recommend that stormwater management in this watershed focus on identifying the source of this contamination. In addition, the CSWAC prioritized this watershed for further study in connection with Volume 2 of this report to identify appropriate stormwater management strategies.

Fisherman Bay Peninsula

Land Use

The existing land use in Fisherman Bay Peninsula is a mix of single-family residential and undeveloped residential lands less than 5 acres in size (see Table 49).

Table 49. Existing Land Use in Fisherman Bay Peninsula.		
Generalized Land Use Category	**Acres**	**Percentage of Total Basin**
Cultural, entertainment and recreational	0	0%
Manufacturing	0	0%
Residential	73	86%
Resource production and extraction	0	0%
Services	0	0%
Transportation, communication and utilities	0	0%
Undeveloped land and water areas	12	14%
Wholesale or retail trade	0	0%
Total	**86**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 86 acres in size and is in the west central portion of Lopez Island. The watershed generally flows to the west into San Juan Channel, and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 96. There is a total elevation drop of about 50 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portion, which steepen near the shoreline. The watershed flow crosses one county road with a culvert.

Peninsula Road - Basin 1 of the watershed is about 50 acres in size and is located in the middle portion of the watershed; see Figure 97. There is a total elevation drop of about 50 feet across this basin. The basin flow begins at a gentle hill and flows west until intercepted by the ditch line of Peninsula Road. The flow crosses Peninsula Road with a 12-inch culvert about 300 feet before entering the channel.

Critical Resources

Aquatic resources in the watershed are summarized in Table 50.

Table 50. Summary of Aquatic Resources in Fisherman Bay Peninsula Watershed.	
Freshwater Wetlands	3 acres (3%)
Tidal Wetlands	0.9 acre (0.9%)
Streams	0 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	0 acres (0%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The outer shoreline of the Fisherman Bay peninsula provides habitat for subtidal geoduck. The small size of the watershed and relatively limited level of development is unlikely to have significant effects on water and sediment quality in the nearshore.

Wetland, Aquatic, and Riparian

Potential wetlands are associated with the back beach areas along the shoreline.

Threatened, Endangered, and Species of Local Concern

Important species present include geoduck clams, eelgrass, and bald eagles.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Fisherman Bay Peninsula watershed.

Risk Summary and Management Recommendations

The Fisherman Bay Peninsula watershed is relatively small with few significant aquatic resources. No stormwater problems have been reported and no water quality data is available. Impervious cover currently represents only 2.1 percent of the watershed and is expected to increase to only 6.2 percent (Table 2) under full buildout conditions. Therefore, this watershed should be a lower priority for stormwater management.

Hughes Bay

Land Use

The existing land use in Hughes Bay includes a mix of undeveloped lands over 5 acres in size, single-family residential, agriculture and designated forest land (see Table 51).

Table 51. Existing Land Use in Hughes Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	32	3%
Manufacturing	0	0%
Residential	276	29%
Resource production and extraction	271	28%
Services	47	5%
Transportation, communication and utilities	0	0%
Undeveloped land and water areas	334	35%
Wholesale or retail trade	0	0%
Total	**960**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 960 acres in size and is in the southern portion of Lopez Island. The watershed generally flows to the south into Hughes Bay, and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 98. There is a total elevation drop of about 300 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions, which steepen near the shoreline. The watershed flow crosses Watmough Bay Road and Cape Saint Mary Road in culverts.

Hughes Bay - Basin 1 of the watershed is several hundred acres in size and is located in the northern portion of the watershed; see Figure 99. There is a total elevation drop of about 300 feet across this basin. The basin flow begins at two gentle hills and flows along the ditch line of Cape Saint Mary Road and Watmough Bay Road to the west and south about 5,000 feet, crossing Watmough Head Road with a 30-inch culvert about 1,200 feet before entering the Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 52.

Table 52. Summary of Aquatic Resources in Hughes Bay Watershed.

Freshwater Wetlands	61 acres (6%)
Tidal Wetlands	0 acres (0%)
Streams	1.3miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	502 acres (51%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The marine shoreline includes Hughes Bay and McArdle Bay. Several pocket beaches provide suitable conditions for a patchy distribution of eelgrass. Kelp is present along the steeper rocky shorelines.

Wetland, Aquatic, and Riparian

The watershed is characterized by the large emergent and forested wetland in its center. Large areas encompassing 51 percent of the watershed are critical aquifer recharge areas. These are generally east of the large wetland and extend around the perimeter of the watershed including along Cape Saint Mary Road, north of Mud Bay Road, and along Aleck Bay Road and Hughes Bay Road. Water generally flows toward the large wetland and away from the mapped aquifer recharge areas.

Threatened, Endangered, and Species of Local Concern

Important species include sea urchin, kelp, and eelgrass. Forested shorelines surrounding McArdle Bay support bald eagles. The rocky islands common around the south end of Lopez

Island support breeding colonies of sea birds, and birds may use nearshore areas for feeding. However, forage fish spawning areas are not mapped within the watershed.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Hughes Bay watershed.

Risk Summary and Management Recommendations

The Hughes Bay watershed has a mix of land uses with the associated existing impervious cover representing only 1.7 percent of the total watershed area. It contains a large emergent and forested wetland but only 1.3 miles of streams. There are no water quality data available, no known flooding problems in the watershed, and impervious surfaces are expected to increase to only 8.9 percent (Table 2) under full buildout conditions. Therefore, we recommend this watershed be a lower priority for stormwater management.

Hunter Bay

Land Use

The existing land use in Hunter Bay is mainly a mix of single-family residential, undeveloped lands over 5 acres in size, agriculture, and vacation homes and cabins (see Table 53).

Table 53. Existing Land Use in Hunter Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	3	0%
Manufacturing	0	0%
Residential	477	38%
Resource production and extraction	377	30%
Services	9	1%
Transportation, communication and utilities	0	0%
Undeveloped land and water areas	379	30%
Wholesale or retail trade	0	0%
Total	**1,245**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,245 acres in size and is in the southeastern portion of Lopez Island. The watershed generally flows to the east into Hunter Bay, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 100. There is a total elevation drop of about 500 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion, which steepen toward the bottom. The watershed flow crosses Hunter Bay Road and Elliot Road, which is private.

Elliot Road - Basin 1 of the watershed is several hundred acres in size and is located in the northern portion of the watershed; see Figure 101. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 2 percent in the middle portion, which steepen toward the bottom. The basin flow connects several wetland and pond areas north of Hunter Bay Road and south of Lopez Sound Road. Flow then continues east in a stream for about 5,000 feet crossing Elliot Private Road with an unknown size culvert about 600 feet before entering Jasper Bay.

Hunter Bay Road - Basin 2 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 102. There is a total elevation drop of about 300 feet across this basin. The basin is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow begins near the intersection of Hunter Bay Road and Cousins Road and flows east and crosses Hunter Bay Road with an 18-inch culvert about 800 feet before entering Hunter Bay where it combines with another stream from the southern portion of this basin.

Critical Resources

Aquatic resources in the watershed are summarized in Table 54.

Table 54. Summary of Aquatic Resources in Hunter Bay Watershed.

Freshwater Wetlands	24 acres (2%)
Tidal Wetlands	0 acres (0%)
Streams	2.5 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	110 acres (9%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Nearshore and marine areas in the watershed support Dungeness crab, Pacific herring, and surf smelt spawning. The relatively low level of development and good vegetated condition of the watershed overall likely reduce the potential for stormwater related impacts on nearshore and other critical resources in this watershed.

Wetland, Aquatic, and Riparian

The watershed contains relatively small wetlands along the two primary drainages. Critical aquifer recharge areas are relatively small portions of recharge areas also present in adjacent watersheds, and include areas near Northstar Road and Willow Lane, and Mud Bay Road, both along the southern boundary of the watershed.

Threatened, Endangered, and Species of Local Concern

Species present include pacific herring, smelt, Dungeness crab, eelgrass, and bald eagles. Eelgrass is primarily present along the south shoreline of Hunter Bay.

Basin Water Quality Evaluation

The only known source of water quality data for the Hunter Bay watershed is:

- **DOH Receiving Water Coliform Monitoring**

Bacteria

Based on bimonthly data collected by the DOH, fecal coliform in Hunter Bay ranged from 1.7 to 21 CFU/100 from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses in Hunter Bay.

Risk Summary and Management Recommendations

Land uses in the Hunter Bay watershed are mixed with the associated existing impervious cover representing only 1.2 percent of the total watershed area. The watershed also contains only 1.2 miles of stream and several relatively small wetlands. However, nearshore and marine areas in the watershed support Dungeness crab, Pacific herring, and surf smelt spawning. There are currently no known flooding or water quality problems in the watershed and impervious surfaces are expected to increase to 11.7 percent (Table 2) under full buildout conditions. Given these considerations, we recommend this watershed be a lower priority for stormwater management.

Iceberg Point

Land Use

The existing land use in Iceberg Point is a mix of open space timber lands with conservation easements, governmental services, agriculture, and educational services (see Table 55).

Table 55. Existing Land Use in Iceberg Point.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	0	0%
Manufacturing	0	0%
Residential	17	8%
Resource production and extraction	66	31%
Services	59	28%
Transportation, communication and utilities	0	0%
Undeveloped land and water areas	69	33%
Wholesale or retail trade	0	0%
Total	**211**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 211 acres in size and is in the south central portion of Lopez Island. The watershed generally flows to the south into the Strait of Juan de Fuca, and consists of many small drainage basins without an apparent a defined outlet into the receiving water; see Figure 103. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portion, which steepen near the shoreline. The watershed flow crosses no county roads with a culvert.

Critical Resources

Aquatic resources in the watershed are summarized in Table 56.

Nearshore and Marine

The steep rocky environment is likely suitable habitat for sea urchin and supports dense kelp populations. The bedrock formation and low level of development limit the potential for stormwater related impacts to nearshore and marine areas in this watershed.

Table 56. Summary of Aquatic Resources in Iceberg Point Watershed.

Freshwater Wetlands	0 acres (0%)
Tidal Wetlands	0 acres (0%)
Streams	0 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	189 acres (90%)

Note: Significant lakes are greater than 20 acres.

Wetland, Aquatic, and Riparian

No significant streams or wetlands are mapped in the watershed. The eastern half of the watershed contains a significant portion of the critical aquifer recharge area that extends from Outer Bay to Aleck Bay. There is a smaller critical aquifer recharge area at the western end of the watershed.

Threatened, Endangered, and Species of Local Concern

Species include sea urchin, subtidal clam species, and kelp.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Iceberg Point watershed.

Risk Summary and Management Recommendations

The Iceberg Point watershed is small, relatively underdeveloped, and contains few significant aquatic resources. No water quality data are available. Impervious cover currently represents only 1.4 percent of the watershed and is expected to increase to 11.4 percent (Table 2) under full buildout conditions. No stormwater problems have been reported. Given these

considerations, we recommend this watershed be a lower priority for stormwater management at this time.

Lopez Sound

Land Use

The existing land use in Lopez Sound is a mix of single-family residential, agriculture, educational services, undeveloped lands over 5 acres in size, and designated forest land (see Table 57).

Table 57. Existing Land Use in Lopez Sound.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	124	5%
Manufacturing	0	0%
Residential	817	35%
Resource production and extraction	686	30%
Services	338	15%
Transportation, communication and utilities	9	0%
Undeveloped land and water areas	316	14%
Wholesale or retail trade	13	1%
Total	**2,304**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 2,339 acres in size and is in the east central portion of Lopez Island. The watershed generally flows to the east into Lopez Sound, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 104. There is a total elevation drop of about 500 feet across the watershed. The watershed is characterized by moderate slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Bakerview Road, and Lopez Sound Road.

Bakerview Road - Basin 1 of the watershed is several hundred acres in size and is located in the northern portion of the watershed; see Figure 105. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland areas east of Port Stanley Road and crosses Bakerview Road with a 36-inch culvert about 600 feet before entering the Lopez Sound.

Lopez Hill - Basin 2 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 106. There is a total elevation drop of about 500 feet across this basin. The basin is characterized by moderate slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent

toward the bottom. The basin flow collects into a wetland area west of Lopez Sound Road and crosses the road with a 30-inch culvert about 400 feet before entering the sound.

Critical Resources

Aquatic resources in the watershed are summarized in Table 58.

Table 58. Summary of Aquatic Resources in Lopez Sound Watershed.

Freshwater Wetlands	169 acres (7%)
Tidal Wetlands	5.9 acres (0.3%)
Streams	4.4 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	69 acres (3%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The northern portion of the shoreline provides habitat for intertidal clams, and Dungeness crab, and supports a mixed population of kelp and eelgrass. Kelp is also present and denser along the southern half of the watershed's marine shoreline. Unstable slopes are present immediately south of Spencer Spit, east of Bakerview Road, and along Spencer Spit State Park Road.

Wetland, Aquatic, and Riparian

The largest wetland in the watershed is surrounded by agricultural fields. It is ditched and drains through a seasonal stream to Lopez Sound. Due to intertidal clam habitat in the nearshore of this watershed, a somewhat rare habitat type in the County, runoff from agricultural areas may represent a potential water quality concern. Other wetlands in the watershed are associated with the a separate ephemeral stream that begins in the area north of School Road and crosses Lopez Sound Road before draining into Lopez Sound.

Threatened, Endangered, and Species of Local Concern

Species include a variety of clams, Dungeness crab, eelgrass, and kelp, and bald eagles.

Basin Water Quality Evaluation

Data from the following water quality monitoring sites were reviewed to identify major trends in water quality in the Lopez Sound watershed:

- **303(d) Listing Status**
- **DOH Receiving Water Coliform Monitoring**

Bacteria

The Unnamed Creek (Tributary to Lopez Sound) is included on the 303(d) list as a Category 5 waterbody impaired for bacteria (Listing 12325). The listing is based on the freshwater primary contact recreation designated beneficial use, which has a fecal coliform criterion of

<100 CFU/100 mL (geometric mean), and ≤10 percent of all samples >200 CFU/100 mL (WAC 173-201A-200). Category 5 waterbodies require development and implementation of the TMDL.

Based on bimonthly data collected by the DOH, fecal coliform in Lopez Sound ranged from 1.7 to 7.8 CFU/100 mL from January 2012 to July 2013, with annual geometric mean values of 2 and 4 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses in Lopez Sound.

Risk Summary and Management Recommendations

Land uses in the Lopez Sound watershed are mixed with the associated existing impervious cover representing only 1.1 percent of the total watershed area. The watershed contains 4.4 miles of stream and nearshore areas support several important species such as intertidal clams, Dungeness crab, and a mixed population of kelp and eelgrass. Under full buildout conditions, impervious surfaces are expected to increase to 6.7 percent (Table 2). While there is currently only one documented ponding problem, one creek in the watershed is currently included on Ecology's 303(d) list as a Category 5 waterbody due to impairment from bacteria. Due to this consideration, stormwater management in this watershed should focus on identifying the sources of this impairment.

Mackaye Harbor

Land Use

The existing land use in Mackaye Harbor is mainly single-family residential and undeveloped lands over 5 acres in size with some designated forest land. Other uses include undeveloped residential lands less than 5 acres in size and agriculture (see Table 59).

Table 59. Existing Land Use in Mackaye Harbor.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	11	1%
Manufacturing	0	0%
Residential	536	56%
Resource production and extraction	168	17%
Services	15	2%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	229	24%
Wholesale or retail trade	0	0%
Total	**961**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 961 acres in size and is in the southern portion of Lopez Island. The watershed generally flows to the west into Mackaye Harbor, and consists of one main drainage basin with a defined outlet into the receiving water; see Figure 107. There is a total elevation drop of about 100 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including MacKaye Harbor Road, and Mud Bay Road.

Mackaye Harbor Road - Basin 1 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 108. There is a total elevation drop of about 100 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and lake areas east of Mackaye Harbor Road and crosses the road with an 18-inch outfall culvert at the beach.

Critical Resources

Aquatic resources in the watershed are summarized in Table 60.

Table 60. Summary of Aquatic Resources in MacKaye Harbor Watershed.

Freshwater Wetlands	52 acres (5%)
Tidal Wetlands	2.6 acres (0.3%)
Streams	0 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	367 acres (36%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Pocket beaches provide suitable habitat for smelt spawning and rocksole spawning has been documented along the shoreline north of Barlow Bay, adjacent to MacKaye Harbor Road. A possible tidal emergent wetland is at the south end of Barlow Bay adjacent to MacKaye Harbor Road. Sloped beaches at the head of MacKaye Harbor and Jones Bay provide continuous populations of eelgrass, while more steeply sloped rocky shorelines contain a patchy distribution of kelp.

Wetland, Aquatic, and Riparian

The majority of the wetland area is associated with the pond east of MacKaye Harbor Road. Critical aquifer recharge areas are located primarily in the forested areas around Normal Road and Dirt Drive, and extend to the shoreline.

Threatened, Endangered, and Species of Local Concern

Important species include smelt, rocksole, sea urchin, kelp, eelgrass, and bald eagles.

Basin Water Quality Evaluation

The following information sources were reviewed to evaluate major trends in water quality in the Mackaye watershed:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The Mackaye watershed was monitored during 2004–2008 at the following location:
    - Site MK5 – culvert on Richardson Road north of Davis Bay Road
- **DOH Receiving Water Coliform Monitoring**

In situ Parameters

Results from 2004–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen and pH levels at the Mackaye Harbor site have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration. Annual average values for turbidity during 2004–2008 were <10 NTU.

Bacteria

Bacteria data collected during the 2004-2008 FHLSOP indicate that fecal coliform levels at the Mackaye Harbor watershed site have consistently met criteria for the primary contact recreation beneficial use, with annual geometric mean values consistently <50 CFU/100 mL and ≤10 percent of sample >200 CFU/100 mL during the monitoring period.

Based on bimonthly data collected by the DOH, fecal coliform in Mackaye Harbor ranged from 1.7 to 23 CFU/100 mL from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses in Mackaye Harbor.

Nutrients

Results from 2004–2008 FHLSOP monitoring indicate that ortho-phosphorus concentrations at the Mackaye Harbor watershed site have not consistently met guidelines adopted by the SJICD (≤0.1 mg/L), with annual average values ranging 0.08-0.18 mg/L, while nitrate concentrations have consistently met the guidelines (≤1 mg/L).

Risk Summary and Management Recommendations

Land use is the Mackaye Harbor watershed is predominantly residential with the associated existing impervious cover representing approximately 3.3 percent of the total watershed area. The primary critical resources in the watershed are wetlands and pocket beaches that provide suitable spawning habitat for smelt and rocksole. A large portion of the watershed (36 percent) is located in an aquifer recharge area. Under full buildout conditions, impervious surfaces are expected to increase to 9.7 percent (Table 2). Existing water quality data indicate generally good conditions although ortho-phosphorus may be problematic in some areas of the watershed. Because there are currently no documented flooding or significant water quality problems under existing conditions, we recommend this watershed be a lower

priority for stormwater management at this time, although continued monitoring would be beneficial.

Mud Bay

Land Use

The existing land use in Mud Bay is a mix of single-family residential, open space, undeveloped residential lands less than 5 acres in size, and undeveloped lands over 5 acres in size (see Table 61).

Table 61. Existing Land Use in Mud Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	0	0%
Manufacturing	0	0%
Residential	505	45%
Resource production and extraction	211	19%
Services	1	0%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	407	36%
Wholesale or retail trade	5	0%
Total	**1,130**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,130 acres in size and is in the southeastern portion of Lopez Island. The watershed generally flows to the northeast into Mud Bay, and consists of one main drainage basins with a defined outlet into the receiving water; see Figure 109. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses Mud Bay Road

Mud Bay Road - Basin 1 of the watershed is several hundred acres in size and is located in the central portion of the watershed; see Figure 110. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas south of Mud Bay Road and crosses Mud Bay Road with a 24-inch culvert about 400 feet before entering the Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 62.

Table 62. Summary of Aquatic Resources in Mud Bay Watershed.	
Freshwater Wetlands	24 acres (2%)
Tidal Wetlands	3.4 acres (0.3%)
Streams	0.3 mile (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	839 acres (71%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Mud Bay is an important Pacific herring spawning area. Smelt spawning is documented along much of the shoreline, primarily along the east shoreline from Mud Bay Dock Road to Doe Run Road. The intertidal zone also supports a variety of clams and Dungeness crab. Significant tidal emergent wetlands are present at the south end of Mud Bay and between Mud Bay and Shoal Bight, adjacent to Sperry Road.

Wetland, Aquatic, and Riparian

Critical aquifer recharge areas are relatively extensive within the watershed. They are primarily west and south of Mud Bay, along Mud Bay Road, and near Pavey Boulevard. Freshwater wetland are somewhat limited in the watershed and occur as small patches. There are no significant streams in the watershed.

Threatened, Endangered, and Species of Local Concern

Important species in Pacific Herring, smelt, Dungeness crab, clams, and eelgrass. Eelgrass is present continuously along the shoreline. Kelp is also present but more limited distribution.

Basin Water Quality Evaluation

The following information sources were reviewed to evaluate major trends in water quality in the Mud Bay watershed:

- **San Juan County Pilot Stormwater Monitoring Program:**
  - Year 1 data are available for the following location:
    - Site L-M1– Mud Bay Road culvert near intersection with Schruder Road
  - During Year 2 of the pilot monitoring effort, the following additional site is being sampled:
    - Site L-M2-M – Mud Bay (receiving water, receiving water sediments)
- **DOH Receiving Water Coliform Monitoring**

In situ Parameters

During the 2012–2013 SJC pilot stormwater monitoring effort, dissolved oxygen ranged 11.6-12.2 mg/L, meeting the minimum freshwater numeric criterion of 8 mg/L for salmonid,

spawning, rearing and migration designated beneficial uses (WAC-173-201A-200) (Stillwater 2014). Turbidity at the 2012–2013 pilot sites was consistently below 50 NTU (Stillwater Sciences 2014). Additional data are needed to characterize current conditions for dissolved oxygen, pH, and turbidity in the Mud Bay watershed, however, due to the low sample size for 2012–2013 (Stillwater Sciences 2014).

Bacteria

Although based on a small sample size (n=2), bacteria data collected during the 2012–2013 SJC pilot stormwater monitoring effort suggest variable levels of fecal coliform by storm event. Instantaneous counts at the Mud Bay Road culvert were >200 CFU/100 mL on one of two sampling occasions, indicating that bacteria levels may exceed the criteria for freshwater primary contact recreation. When compared across all six pilot study focus areas, Mud Bay is among those focus areas (along with Fisherman Bay and East Sound) that exhibit relatively higher fecal coliform and *E. coli* counts for 2012-2013 (Table 4). Additional data collected during years 2 and 3 should allow for a more definitive comparison between focus areas and may allow for identification of specific sources of bacteria within each focal area.

Based on bimonthly data collected by the DOH, fecal coliform in Mud Bay ranged from 1.7 to 23 CFU/100 from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses in Mud Bay.

Nutrients

During the 2012-2013 SJC pilot stormwater monitoring effort, nutrient concentrations at the Mud Bay Road culvert were high compared with values measured in the other five San Juan County focus areas (Table 3). Total phosphorus was also high compared to values measured in Puget Sound Phase 3 monitoring (Ecology and King County 2011) and three national databases of monitored stormwater concentrations (Stillwater Sciences 2014). However, additional data are needed to confirm this trend due to the low sample size (Stillwater Sciences 2014).

Metals

During 2012–2013, total metals were relatively low at the Mud Bay Road culvert (arsenic 1 ug/L; cadmium <0.25 ug/L; copper 7.4–10 ug/L; lead 0.7 ug/L; zinc 5.2–6 ug/L) compared with reported values for typical urban stormwater runoff and Puget Sound Puget Sound Phase 3 monitoring (Ecology and King County 2011). All dissolved metals were below available Ecology hardness-based acute and chronic numeric criteria for aquatic life toxicity, suggesting a low toxicity potential in Mud Bay stormwater with respect to metals. Since hardness was only collected during the April 5, 2013 storm event, however, additional data are needed to confirm this result (Stillwater Sciences 2014).

TPHs and Herbicides/Pesticides

Measured concentrations of TPHs (benzene, toluene, ethyl-benzene, total xylenes, and gasoline [C8-C12]) were below the analytical detection limits (0.4–100 ug/L) during 2012-2013 San Juan County pilot stormwater monitoring. Herbicides/pesticides commonly used in

San Juan County, including permethrin, MGK-264, and glyphosate, were below the analytical detection limits (0.1–10 ug/L) at the Mud Bay Road culvert during 2012-2013.

Surfactants

Anionic surfactants measured at the Mud Bay Road culvert for a single sampling event during 2012-2013 (0.25 ug/L) was on the low end of previous measurements reported for multiple sites across the San Juan Islands (i.e., range = 0.17–1.3 ug/L, mean = 0.57 ug/L; Barsh et al. 2008) and are far below the available USEPA criterion[1] for drinking water sources (500 ug/L). However, additional data are needed to confirm this result due to the low sample size (Stillwater Sciences 2014).

Risk Summary and Management Recommendations

Land use in the Mud Bay watershed is mixed with the associated existing impervious cover representing only 1.8 percent of the total watershed area. Although freshwater wetlands are somewhat limited and there are no significant streams in the watershed, nearshore areas of the watershed provide important habitat for Pacific herring and smelt spawning while intertidal zones support a variety of clams and Dungeness crab. Under full buildout conditions, impervious surfaces are expected to increase to 9.1 percent (Table 2). While there are currently no documented flooding problems, relatively high concentrations of fecal coliform have been measured under existing conditions and nutrient concentrations are also high in some areas. Given this consideration, we recommend that stormwater management in this watershed focus on identifying the source of these contaminants. The CSWAC has also selected this watershed as high priority for further study in connection with Volume 2 of this report to identify appropriate stormwater management strategies.

Outer Bay

Land Use

The existing land use in Outer Bay is a mix of governmental services, single-family residential and open space with conservation easements (see Table 63).

Table 63. Existing Land Use in Outer Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	2	1%
Manufacturing	0	0%
Residential	50	34%
Resource production and extraction	2	2%
Services	43	29%
Transportation, communication and utilities	0	0%
Undeveloped land and water areas	52	35%
Wholesale or retail trade	0	0%
Total	**149**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 150 acres in size and is in the south central portion of Lopez Island. The watershed generally flows to the south into Outer Bay, and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 111. There is a total elevation drop of about 200 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions, which steepen near the shoreline. The watershed flow crosses one county road with a culvert.

Flint Road - Basin 1 of the watershed is less than a hundred acres in size and is located in the northern portion of the watershed; see Figure 112. There is a total elevation drop of about 200 feet across this basin. The basin flow begins at two gentle hills and flows along the ditch line of Flint Road to the north about 1200 feet, crossing Mackaye Harbor Road with a 12-inch culvert about 300 feet before entering the Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 64.

Table 64. Summary of Aquatic Resources in Outer Bay Watershed.

Freshwater Wetlands	0 acres (0%)
Tidal Wetlands	0 acres (0%)
Streams	0 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	73 acres (49%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Smelt spawning has been documented along the beach adjacent to MacKaye Harbor Road. The area is likely used by breeding sea birds for foraging. Eelgrass along the pocket beach may contribute to the suitability of the habitat for forage fish.

Wetland, Aquatic, and Riparian

Wetlands are essentially absent from the watershed and there are no significant streams. Critical aquifer recharge areas include a large area that extends across the watershed to the east and west from Flint Road, and along the same portion of beach that supports smelt spawning.

Threatened, Endangered, and Species of Local Concern

Important species present include forage fish, sea urchin, kelp, and eelgrass.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Outer Bay watershed.

Risk Summary and Management Recommendations

The Outer watershed is small, relatively underdeveloped, and contains few significant aquatic resources. Water quality data is unavailable and there are no reported stormwater problems. Impervious cover currently represents only 2.2 percent of the watershed and is expected to increase to 8.9 percent (Table 2) under full buildout conditions. Given these considerations, we recommend this watershed be a lower priority for stormwater management.

San Juan Channel (Lopez)

Land Use

The existing land use in San Juan Channel (Lopez) is mainly single-family residential. Other uses include undeveloped lands over 5 acres in size, undeveloped residential lands less than 5 acres in size, and aircraft transportation (see Table 65).

Table 65. Existing Land Use in San Juan Channel (Lopez).

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	30	7%
Manufacturing	0	0%
Residential	298	67%
Resource production and extraction	7	2%
Services	18	4%
Transportation, communication and utilities	34	8%
Undeveloped land and water areas	56	13%
Wholesale or retail trade	0	0%
Total	**442**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 442 acres in size and is in the south central portion of Lopez Island. The watershed generally flows to the west into San Juan Channel, and consists of only one main drainage basin with a defined outlet into the receiving water; see Figure 113. There is a total elevation drop of about 200 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle portions, which steepen near the shoreline. The watershed flow crosses one county road with a culvert.

Channel Road - Basin 1 of the watershed is less than a hundred acres in size and is located in the northern portion of the watershed; see Figure 114. There is a total elevation drop of about 200 feet across this basin. The basin flow begins at a gentle hill and flows along the ditchline of Channel Road to the south and west about 2,000 feet, crossing Channel Road with a 12-inch culvert about 500 feet before entering San Juan Channel.

Critical Resources

Aquatic resources in the watershed are summarized in Table 66.

Table 66. Summary of Aquatic Resources in San Juan Channel (Lopez) Watershed.	
Freshwater Wetlands	7 acres (2%)
Tidal Wetlands	0 acres (0%)
Streams	0.3 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	65 acres (14%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The marine shoreline is characterized by a steep unstable slope. The forested bluff provides suitable perches and potential nest sites for bald eagles. The shoreline is characterized by a continuous population of eelgrass that likely provides good habitat for forage fish and migrating salmon.

Wetland, Aquatic, and Riparian

Wetlands are present in the more gently sloped or flat areas farther inland. Wetlands are generally small and distributed throughout the watershed. A critical aquifer recharge area is near the airport and Lopez Island Gulf Club. Streams are generally absent but a small ephemeral stream flows through a well-vegetated area from near the airport to San Juan Channel.

Threatened, Endangered, and Species of Local Concern

Important species present include sea urchin, eelgrass, and bald eagles.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the San Juan Channel (Lopez) watershed.

Risk Summary and Management Recommendations

Land use in the San Juan Channel (Lopez) watershed is a mainly residential with the associated existing impervious cover representing 6.6 percent of the total watershed area. While forest bluffs in nearshore areas of the watershed provide suitable perches and potential nest sites for bald eagles, there are otherwise few freshwater aquatic resources. No water quality data are available. Under full buildout conditions, impervious surfaces are expected to increase to 10.3 percent (Table 2). Because there are currently no documented flooding problems under existing conditions, we recommend this watershed be a lower priority for stormwater management at this time.

Shoal Bay

Land Use

The existing land use in Shoal Bay is mostly a mix of single-family residential and agriculture with some undeveloped lands over 5 acres in size and vacation homes and cabins (see Table 67).

Table 67. Existing Land Use in Shoal Bay.		
Generalized Land Use Category	**Acres**	**Percentage of Total Basin**
Cultural, entertainment and recreational	6	1%
Manufacturing	0	0%
Residential	298	59%
Resource production and extraction	85	17%
Services	17	3%
Transportation, communication and utilities	3	1%
Undeveloped land and water areas	90	18%
Wholesale or retail trade	8	2%
Total	**507**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 507 acres in size and is in the south central portion of Lopez Island. The watershed generally flows to the south into False Bay, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 115. There is a total elevation drop of about 200 feet across the watershed. The watershed is characterized by steep slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Beaverton Valley Road, Boyce Road, Wold Road, San Juan Valley Road, and Bailer Hill Road.

Shoal Bay - Basin 1 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 116. There is a total elevation drop of about 100 feet across this basin. The basin is characterized by gentle slopes in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland areas between Ferry Road, Jensen Road, and Center Road. Flow continues north about 4,000 feet to Shoal Bay across a very gentle valley with wetland areas, crossing Port Stanley Road with a 24-inch culvert about 400 feet before entering the Bay.

Ferry Landing - Basin 2 of the watershed is less than a hundred acres in size and is located in the northern portion of the watershed; see Figure 117. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by steep slopes in the upper portion that flatten to about 5 percent toward the bottom. The basin flow includes the narrow area to the ridge top west of Ferry Road and is captured by the road side ditch flowing north to a single outlet point north of the Ferry Landing

Critical Resources

Aquatic resources in the watershed are summarized in Table 68.

Table 68. Summary of Aquatic Resources in Shoal Bay Watershed.	
Freshwater Wetlands	52 acres (10%)
Tidal Wetlands	0 acres (0%)
Streams	0.8 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	0 acres (0%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Shoal Bay is an important Pacific Herring spawning area and the beach along the south shoreline provides suitable habitat used by surf smelt for spawning. Smelt spawning has also been documented near the ferry terminal. Dungeness crab are also present. There is a pocket estuary in the southeast corner of the bay, which receives a limited amount of stormwater flow. The eastern shoreline of shoal bay is a steep unstable slope. Due to its close proximity to the marine shoreline and potential smelt spawning areas, runoff from the ferry holding lanes (observed to contain visible sheens) could represent a potential opportunity for stormwater improvement.

Wetland, Aquatic, and Riparian

The drainage that crosses Fisherman Bay Road and Ferry Road includes associated, intermittent, or connected emergent wetlands along its path. The wetlands are within deforested agricultural fields and drain to Shoal Bay near Naylor Close Road, where forage fish spawning has been documented.

Threatened, Endangered, and Species of Local Concern

Important species present include Pacific herring, smelt, Dungeness crab, and bald eagles and seabirds along the steep eastern shoreline. The southern shoreline of the bay supports dense eelgrass and kelp, while the western and eastern shorelines are characterized by patchy kelp populations.

Basin Water Quality Evaluation

Limited data are available for evaluating major trends in water quality in the Shoal Bay watershed. The only known source of data is:

- **DOH Receiving Water Coliform Monitoring**

Bacteria

Based on bimonthly data collected by the DOH, fecal coliform in Shoal Bay ranged from 1.7 to 17 CFU/100 mL from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses in Shoal Bay.

Risk Summary and Management Recommendations

Land uses in the Shoal Bay watershed are mixed with the associated existing impervious cover representing only 4.3 percent of the total watershed area. While the watershed contains few freshwater aquatic resources, nearshore areas provide important habitat for Pacific herring, smelt, Dungeness crab, and bald eagles and seabirds. Limited water quality monitoring of bacteria indicated no issues. Under full buildout conditions, impervious surfaces are expected to increase to 10.2 percent (Table 2). There are two documented stormwater problems related to the ferry landing. Given there are few existing stormwater problems, we recommend this watershed be a lower priority for stormwater management at this time.

Swift Bay

Land Use

The existing land use in Swift Bay is a mix of single-family residential, agriculture and undeveloped lands over 5 acres in size (see Table 69).

Table 69. Existing Land Use in Swift Bay.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	43	2%
Manufacturing	9	1%
Residential	960	55%
Resource production and extraction	354	20%
Services	1	0%
Transportation, communication and utilities	1	0%
Undeveloped land and water areas	376	21%
Wholesale or retail trade	4	0%
Total	**1,748**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,748 acres in size and is in the south central portion of Lopez Island. The watershed generally flows to the south into Swift Bay, and consists of one main drainage basin with a defined outlet into the receiving water; see Figure 118. There is a total elevation drop of about 250 feet across the watershed. The watershed is characterized by gentle slopes in the upper and middle portions, up to about 5 percent that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Hummel Lake Road, Cross Road, and Port Stanley Road.

Hummel Lake - Basin 1 of the watershed is about 1,700 acres in size and includes almost all of the watershed flowing into Swift Bay; see Figure 119. The basin flow connects several wetland and lake areas west of Center Road and south of Hummel Lake and crosses Center Road with an 18-inch culvert and into Hummel Lake, then crosses Hummel Lake Road with a 24-inch culvert. Flow then continues north about 1.2 miles to Cross Road across a very gentle

valley with wetland areas, crossing Cross Road continuing about 2,000 feet and crossing Port Stanley road with a 36-inch culvert at the shoreline.

Critical Resources

Aquatic resources in the watershed are summarized in Table 70.

Table 70. Summary of Aquatic Resources in Swift Bay Watershed.	
Freshwater Wetlands	238 acres (13%)
Tidal Wetlands	0 acres (0%)
Streams	4.5 miles (0.2 mile fish-bearing)
Significant Lakes	Hummel Lake (36 acres)
Aquifer Recharge Areas	168 acres (9%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Swift Bay contain suitable habitat for Dungeness crab and supports eelgrass in a continuous distribution along most of its shoreline.

Wetland, Aquatic, and Riparian

Emergent wetlands are associated with headwaters that flow into Hummel Lake. Water then drains north through a series of forested wetlands and then into Swift Bay. Hummel Lake contains habitat for resident trout. There is a critical aquifer recharge area west of Port Stanley Road that extends from Bakerview Road to Swift Bay.

Threatened, Endangered, and Species of Local Concern

Important species present include Dungeness crab, eelgrass, bald eagles, and cutthroat trout (Hummel Lake). A variety of waterfowl and bald eagles have also been observed around Hummel Lake.

Basin Water Quality Evaluation

Limited data are available for evaluating major trends in water quality in the Swift Bay watershed. The only known source of data is:

- **Friday Harbor Labs Science Outreach Program (FHLSOP) – San Juan Islands Watershed Project**: The Swifts Bay watershed was monitored during 2004–2008 at the following location:
    - Site SB1 – Culvert at Cross Road

In situ Parameters

Results from 2004–2008 FHLSOP monitoring indicate that water temperature, dissolved oxygen and pH levels at Swifts Bay have been generally supportive of Ecology designated beneficial uses including for salmonid spawning, rearing, and migration.

Bacteria

Bacteria data collected during the 2004–2008 FHLSOP indicate that fecal coliform levels in the Swifts Bay watershed have met criteria for the primary contact recreation beneficial use, with annual geometric mean values consistently <100 CFU/100 mL.

Nutrients

Results from 2006-2008 FHLSOP monitoring indicate ortho-phosphorus concentrations at the Swifts Bay site have not consistently met guidelines adopted by the SJICD (≤0.1 mg/L), while nitrate concentrations have consistently met the guidelines (≤1 mg/L).

Risk Summary and Management Recommendations

Land uses in the Swift Bay watershed are mixed with the associated existing impervious cover representing only 2.1 percent of the total watershed area. The watershed contains 4.5 miles of stream and several important emergent wetlands that are hydraulically connected with Hummel Lake. Hummel Lake contains habitat for resident trout and nearshore areas of the watershed contain suitable habitat for Dungeness crab. Under full buildout conditions, impervious surfaces are expected to increase to 8.6 percent (Table 2). Water quality monitoring indicates somewhat elevated ortho-phosphorus concentrations may be coming from the watershed. Stormwater problem reporting has been minimal with some ponding and flooding reported as well as damage to private property. We recommend that stormwater management in this watershed emphasize water quality protection for Hummel Lake and its tributary wetlands.

Upright Channel

Land Use

The existing land use in Upright Channel is a mix of single-family residential, agriculture, undeveloped lands over 5 acres in size, parks, and vacation homes and cabins (see Table 71).

Table 71. Existing Land Use in Upright Channel.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	93	8%
Manufacturing	0	0%
Residential	610	54%
Resource production and extraction	189	17%
Services	96	8%
Transportation, communication and utilities	7	1%
Undeveloped land and water areas	135	12%
Wholesale or retail trade	1	0%
Total	**1,130**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 1,130 acres in size and is in the northern tip of Lopez Island. The watershed generally flows to the south into Upright Channel, and consists of two main drainage basins with defined outlets into the receiving water; see Figure 120. There is a total elevation drop of about 200 feet across the watershed. The watershed is characterized by slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The watershed flow crosses Fisherman Bay Road and Lopez Road.

Odlin Park - Basin 1 of the watershed is several hundred acres in size and is located in the northern portion of the watershed; see Figure 121. There is a total elevation drop of about 200 feet across this basin. The basin is characterized by gentle slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow begins south of the Fisherman Bay Road and Center Road intersection and crosses Fisherman Bay Road with a 12-inch and 18-inch culvert. Flow then continues north about 0.5 miles to False Bay across a very gentle valley wetland area south of Odlin County Park, crossing the park and entering Upright Channel with an 18-inch culvert with tidal gate due to low elevations.

Southern - Basin 2 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 122. There is a total elevation drop of about 100 feet across this basin. The basin is characterized by slopes up to about 5 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas between Fisherman Bay Road and Lopez Road and finally crosses Lopez Road with a 30-inch culvert about 400 feet before entering the Bay, north of Lopez Village.

Critical Resources

Aquatic resources in the watershed are summarized in Table 72.

Table 72. Summary of Aquatic Resources in Upright Channel Watershed.

Freshwater Wetlands	50 acres (4%)
Tidal Wetlands	1.6 acres (0.1%)
Streams	0.7 mile (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	167 acres (14%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The nearshore along Upright Channel has similar characteristics as Lopez Island's San Juan Channel watershed. Unstable slopes are common along most of its length. Eelgrass occurs in a dense distribution.

Wetland, Aquatic, and Riparian

The largest wetland area is associated with Flat Point Lake, although significant patches are also present in the gently sloped area between Lopez Road and Fisherman Bay Road in the southern portion of the watershed. Streams are somewhat limited in the watershed, but several ephemeral drainages are present, and drain the scattered wetlands and Flat Point Lake to Upright Channel. A critical aquifer recharge area extends approximately 1 mile in a southerly direction from Flat Point Lake, and includes areas near Military Road and east of Lopez Road.

Threatened, Endangered, and Species of Local Concern

Important species present include eelgrass and bald eagles. The relatively continuous occurrence of eelgrass may also provide suitable habitat for migrating salmon, forage fish, and other species that are important food for sources for other species.

Basin Water Quality Evaluation

Limited data are available for evaluating major trends in water quality in the Upright Channel watershed. The only known source of data is:

- **DOH Receiving Water Coliform Monitoring**

Bacteria

Based on bimonthly data collected by the DOH, fecal coliform in Upright Channel ranged from 1.7 to 33 CFU/100 mL from January 2012 to July 2013, with an annual geometric mean of 2 CFU/100 mL and no samples >43 CFU/100 mL (J. Schultz, DOH, and E. Hale, San Juan County Department of Public Works, November 19, 2013; personal communication). These samples meet the criteria for the marine primary contact recreation designated beneficial uses in Upright Channel.

Risk Summary and Management Recommendations

Land uses in the Upright Channel watershed are mixed with the associated existing impervious cover representing only 2.8 percent of the total watershed area. The watershed contains some large wetlands but only 0.7 miles of stream. Nearshore areas provide important habitat for eelgrass and bald eagles. Under full buildout conditions, impervious surfaces are expected to increase to 7.2 percent (Table 2). There are currently no documented flooding or water quality problems in the watershed, albeit water quality data are limited. Therefore, we recommend this watershed be a lower priority for stormwater management at this time.

Watmough Bay

Land Use

The existing land use in Watmough Bay is a mix of single-family residential, open space, agriculture, undeveloped lands over 5 acres in size, and parks (see Table 73).

Table 73. Existing Land Use in Watmough Bay.		
Generalized Land Use Category	**Acres**	**Percentage of Total Basin**
Cultural, entertainment and recreational	88	10%
Manufacturing	0	0%
Residential	257	29%
Resource production and extraction	138	15%
Services	15	2%
Transportation, communication and utilities	2	0%
Undeveloped land and water areas	400	44%
Wholesale or retail trade	0	0%
Total	**901**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 901 acres in size and is in the southeast portion of Lopez Island. The watershed generally flows to the south and east into Telegraph Bay and Watmough Bay, and consists of two main drainage basins with a defined outlet into the receiving water; see Figure 123. There is a total elevation drop of about 450 feet across the watershed. The watershed is characterized by steep slopes in the hilly areas to the south, and gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses two county roads within culverts.

Telegraph Bay - Basin 1 of the watershed is less than one hundred acres in size and is located in the northern portion of the watershed; see Figure 124. There is a total elevation drop of about 150 feet across this basin. The basin is characterized by gentle slopes in the upper portion that flatten to about 1 percent toward the bottom. The basin flow connects several small wetland areas north of Cape Saint Mary Road and then crosses the road with a 12-inch culvert and continues about 1,200 feet to the southeast before entering the Bay.

Watmough Bay - Basin 2 of the watershed is several hundred acres in size and is located in the southern portion of the watershed; see Figure 125. There is a total elevation drop of about 450 feet across this basin. The basin is characterized by very steep slopes in the upper portion, that flatten to about 1 percent toward the bottom. The basin flow connects two wetland areas on the north and south sides of Watmough Bay Road crossing the road with an unknown size culvert and having a total flowpath of about 3,000 feet before entering Watmough Bay.

Critical Resources

Aquatic resources in the watershed are summarized in Table 74.

Table 74. Summary of Aquatic Resources in Watmough Bay Watershed.	
Freshwater Wetlands	33 acres (4%)
Tidal Wetlands	0 acres (0%)
Streams	0.1 mile (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	240 acres (26%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The nearshore and marine environment adjacent to this watershed is characterized by swift currents and a steep, rocky shoreline. The habitat is suitable for kelp, which is present along much of the shoreline, and for sea urchins. The mostly forested shoreline also provides good habitat for bald eagles and other birds.

Wetland, Aquatic, and Riparian

Significant wetlands include one at Watmough Bay behind the beach, and a nearby forested wetland south of Watmough Head Road. Smaller wetlands are scattered throughout the watershed. Critical aquifer recharge areas are present from the watershed boundary east of Sperry Road, along Cape Saint May Road and extending east to the shoreline. Another aquifer recharge area is along Watmough Head Road in the southern portion of the watershed. A general lack of significant streams and the relatively undeveloped and forested character of the watershed likely limits the potential for stormwater to impact nearshore and other critical resources.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Watmough watershed.

Risk Summary and Management Recommendations

Land uses in the Watmough Bay watershed are mixed with the associated existing impervious cover representing less than 1 percent of the total watershed area. A significant portion of the watershed is located in an aquifer recharge area (26 percent). Nearshore areas provide important habitat for bald eagles and other birds and kelp forests line much of the shore. Under full buildout conditions, impervious surfaces are expected to increase to 8 percent (Table 2). No water quality data is available. Because there are currently no documented stormwater problems under existing conditions, we recommend this watershed be a lower priority for stormwater management at this time.

Shaw Island

Land Use

The existing land use on Shaw Island is a mix of single-family residential, undeveloped lands over 5 acres in size, educational services, open space with conservation easements,

undeveloped residential lands less than 5 acres in size, and undeveloped lands with conservation easements (see Table 75).

Table 75. Existing Land Use in Shaw Island.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	59	1%
Manufacturing	8	0%
Residential	1,639	34%
Resource production and extraction	460	10%
Services	695	15%
Transportation, communication and utilities	81	2%
Undeveloped land and water areas	1,844	39%
Wholesale or retail trade	1	0%
Total	**4,786**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

The watershed is approximately 4,786 acres in size and includes all of Shaw Island. The watershed generally flows to the south into the Salish Sea, and consists of three main drainage basins with defined outlets into the receiving water; see Figure 126. There is a total elevation drop of about 350 feet across the watershed. The watershed is characterized by moderate slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The watershed flow crosses several county roads in culverts including Neck Point Road, Blind Bay Road, Hoffman Road, and Squaw Bay Road.

Broken Point - Basin 1 of the watershed is several hundred acres and in the northwest portion of the watershed. There is a total elevation drop of about 220 feet across this basin. The basin is gentle sloped up to about 2 percent to 5 percent. The basin flow connects several wetland and pond areas north of Neck Point Rood and Ben Nevis Loop. The flows to the north in a stream for about 4,000 feet and outlets into the bay west of Broken Point.

Squaw Bay - Basin 2 of the watershed is several hundred acres in size and is in the south central portion of the watershed. There is a total elevation drop of about 250 feet across this basin. The basin is characterized by moderate slopes in the upper portion, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. The basin flow connects several wetland and pond areas south of Neck Point Road, flowing to the southeast in a stream for about 4,000 feet. The flow crosses Hoffman Cove Road with a 15-inch culvert and flows about 3,000 feet before entering Squaw Bay.

Blind Bay - Basin 3 of the watershed is several hundred acres in size and is in the central portion of the watershed. There is a total elevation drop of about 350 feet across this basin. The basin is characterized by moderate slopes in the upper portion which in the middle portion flatten to about 5 percent toward the bottom. The basin flow collects in a wetland

area northwest of Neck Point Road and Ben Nevis Loop and crosses Ben Nevis Loop with a 12-inch culvert and Blind Bay Road with an 18-inch culvert. It then connects with several ponds and wetland areas and forms a stream for about 6,000 feet before crossing Blind Bay Road near Smugglers Cove Road within a 36-inch culvert. After that, it continues west about 400 feet before entering another pond and then 800 feet further to the Bay near the end of Graceland Drive.

Critical Resources

Aquatic resources in the watershed are summarized in Table 76.

Table 76. Summary of Aquatic Resources in Shaw Island Watershed.

Freshwater Wetlands	105 acres (2%)
Tidal Wetlands	0 acres (0%)
Streams	10.6 miles (0 miles fish-bearing)
Significant Lakes	None
Aquifer Recharge Areas	105 acres (2%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

Nearshore areas provide suitable habitat for juvenile salmon and forage fish. Eelgrass beds occur in a patchy distribution throughout most of the reaches, and provide habitat for fish, including suitable spawning habitat for Pacific herring in Blind Bay. Blind is also important habitat for Dungeness crab. Surf smelt spawning habitat is present along the beach in Blind Bay and in a patchy distribution along Shaw Island's northern shoreline between Broken Point and Point Hudson. Kelp has a patchy distribution throughout the watershed. Juvenile Chinook, chum, and pink salmon presence have been documented in nearshore areas of Parks Bay and Hicks Cove (Wyllie-Echeverria and Barsh 2007), and as in many other parts of the County, are likely present throughout other nearshore areas. Estuarine habitat is present in Blind Bay, Parks Bay, and Indian Cove, and there are several smaller pocket estuaries along the San Juan Channel shoreline.

Wetland, Aquatic, and Riparian

Several small ephemeral drainages are on Shaw Island and they are well vegetated and contain a patchwork of associated wetlands. Forested areas, primarily along the eastern and southern shorelines of Shaw Island provide suitable habitat for bald eagles, and are used by bald eagles for nesting and perching. Critical aquifer recharge areas are primarily located west of Blind Bay along Smuggler's Cove Road, and in areas west of Osprey Pond. The relative well-vegetated and undeveloped character of the watershed overall may limit the potential for stormwater impacts on critical resources compared to other locations in the County.

Threatened, Endangered, and Species of Local Concern

Important species present include sea urchin, Pacific herring, smelt, eelgrass and kelp, Dungeness crab, and bald eagles.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Shaw Island watershed.

Risk Summary and Management Recommendations

The Shaw Island watershed is dominated by residential land use and currently has 1.7 percent impervious cover. This is estimated to increase to 9.2 percent at buildout (Table 2). There are no water quality data available for this watershed. There are reports of flooding and erosion (Appendix C). In the absence very much information for this watershed, we recommend that some monitoring of this watershed be implemented as it has a rich shoreline ecosystem and numerous stream that discharge to marine waters. Stream monitoring and an investigation of the reported stormwater problems would be useful to evaluate whether there are water quality issues and to establish a baseline for assessing whether degradation occurs as the watershed further develops.

Populated Outer Islands

The populated outer islands include Blakely, Brown, Canoe, Center, Crane, Decatur, Henry, Obstruction, Stuart, and Waldron islands.

Land Use

The existing land use on the populated outer islands is mainly a mix of designated forest land with conservation easements, undeveloped lands over 5 acres in size, and designated forest land. Other uses include single-family residential and other undeveloped lands (see Table 77).

Table 77. Existing Land Use in the Populated Outer Islands.

Generalized Land Use Category	Acres	Percentage of Total Basin
Cultural, entertainment and recreational	529	4%
Manufacturing	0	0%
Residential	3,499	27%
Resource production and extraction	4,584	35%
Services	59	0%
Transportation, communication and utilities	114	1%
Undeveloped land and water areas	4,146	32%
Wholesale or retail trade	0	0%
Total	**12,931**	**100%**

Source: San Juan County (2013)

Stormwater Infrastructure

All of the populated outer islands encompass an area of approximately 12,931 acres in size and all drain runoff directly into the Salish Sea. The area comprises five larger islands, considered drainage basins, with defined outlets into the receiving water. No data on culverts or other storm water structures are mapped for these islands.

Henry Island - Basin 1 of the watershed is the entire island, is 1,019 acres in size, and is located in the southeast of San Juan County; see Figure 127. There is a total elevation drop of about 250 feet across this island and it rarely has year round residents. The island is characterized by moderate slopes in the upper portion that flatten to about 5 percent toward the middle of the island. There are no County roads, but a few private roads, and some wetland areas generally toward the southeast, with most flows draining into Nelson Bay.

Stuart Island - Basin 2 of the watershed is the entire island, which is 1,844 acres in size and is located in the southeast portion of San Juan County; see Figure 128. There is a total elevation drop of about 600 feet across this island and a year round population of about 100 residents. The island is characterized by steep slopes in the upper portion that flatten to about 5 percent toward the bottom in the valley near Lighthouse Road. There is a small network of County roads, an airfield, and some wetland areas toward the northeast on the island that flow out into Prevost Harbor.

Waldron Island - Basin 3 of the watershed is the entire island, is 2,944 acres in size, and is located in the northwest portion of San Juan County; see Figure 129. There is a total elevation drop of about 500 feet across this island and a year round population of about 104 residents. The island is characterized by steep slopes in the small upper portion that flatten to about 5 percent toward the middle and bottom portions on the western side of the island. There is a small network of County roads, an airfield and some wetland areas generally toward the southwest on the island, that flow into Cowlitz Bay.

Blakely Island - Basin 4 of the watershed is the entire island, is 4,164 acres in size, and is located in the western portion of San Juan County; see Figure 130. There is a total elevation drop of about 1,000 feet across this island and a year round population of about 56 residents. The island is characterized by steep slopes in the upper portion that flatten to about 5 percent only in a small area on the northwest tip of the island. Two large lakes are on the island, which combine flows and outlet to Thatcher Bay on the southwest side of the island. Development on the island is almost entirely concentrated in the flatter area on the northwest tip. There are no county roads, but several private roads an airfield and some wetland areas on the island.

Decatur Island - Basin 5 of the watershed is the entire island, which is 2,255 acres in size and is located in the southeast portion of San Juan County; see Figure 1301. There is a total elevation drop of about 350 feet across this island and a year round population of about 71 residents. The island is characterized by steep slopes in the upper portion that flatten to about 5 percent toward the bottom on the southern half of the island. There is a small network of county roads, an airfield and some wetland areas generally toward the south west on the island.

Smaller Islands - Basin 6 of the watershed includes the smaller populated islands of Pearl, Crane, Canoe, Center, Brown, and Obstruction Island which are each under 250 acres size and are located throughout the San Juan Islands. There is a total elevation drop of up to 250 feet across these islands, and little potential for stormwater impacts, with the possible exception of Crane Island and Center Island, which each have airfields and up to 50 year round residents.

Critical Resources

Aquatic resources in the watershed are summarized in Table 78.

Table 78. Summary of Aquatic Resources in the Populated Outer Islands.

Island	Freshwater Wetlands	Tidal Wetlands	Streams	Significant Lakes	Aquifer Recharge Areas
Blakely	197 acres (5%)	None	7.8 miles (1.81 miles fish-bearing)	Horseshoe Lake (84 acres) Spencer Lake (64 acres)	335 acres (8%)
Brown	None	None	None	None	None
Canoe	None	None	None	None	None
Center	None	None	None	None	51 acres (30%)
Crane	None	None	0.1 mile (0 miles fish-bearing)	None	None
Decatur	48 acres (2%)	12.9 (0.6%)	0.3 mile (0 miles fish-bearing)	None	428 acres (19%)
Henry	16 acres (2%)	28.4 acres (2.8%)	0.1 mile (0 miles fish-bearing)	None	None
Obstruction	None	None	None	None	None
Pearl	None	None	None	None	None
Stuart	31 acres (2%)	1.3 acres (0.1%)	0.7 mile (0 miles fish-bearing)	None	277 acres (15%)
Waldron	52 acres (2%)	None	1.3 miles (0 miles fish-bearing)	None	1,414 acres (49%)

Note: Significant lakes are greater than 20 acres.

Nearshore and Marine

The geographic and geomorphic variability between the populated outer islands result in a wide range of habitat and presence of nearshore resources. In general, the limited level of development, impervious surface, and stormwater infrastructure, in conjunction with relatively good vegetated conditions, limit the potential for significant stormwater related impacts on nearshore and marine environments surrounding these islands. A significant tidal emergent wetland is present between Nelson Bay and Open Bay on Henry Island, as well adjacent to Reads Bay along Reed Shipyard Road on Decatur Island.

Wetland, Aquatic, and Riparian

Freshwater wetlands are limited in general, and are primarily associated with the various lakes on the islands. Significant lakes including Horseshoe Lake and Spencer Lake on Blakely Island support planted rainbow trout populations. Critical aquifer recharge areas a generally present in the lower elevations. Aquifer recharge areas are mapped within all of the islands except Henry Island.

Threatened, Endangered, and Species of Local Concern

Smelt spawning has been documented along some of the bluff backed beaches such as Reeds Bay (Decatur Island) and Thatcher Bay (Blakely Island), and Cowlitz Bay (Waldron Island) at the end of Cowlitz Bay Waldron Center Road. Reeds Bay and Roach Harbor provide habitat for Dungeness crab. These areas generally contain eelgrass populations. Other shorelines are more suitable for kelp and sea urchins. Salmon, sea birds, and bald eagles are present throughout the nearshore areas of the outer islands.

Basin Water Quality Evaluation

We are unaware of water quality data sufficient for evaluating trends in the Populated Outer Islands.

Risk Summary and Management Recommendations

There is very little stormwater related information on the populated outer islands. Forestry and farming are prominent land uses on the populated outer islands followed by residential development. There are important freshwater resources throughout the outer islands and a wide range of rich marine environments in the near shore. We have no water quality data for the Populated Outer Island watershed and no stormwater problems were reported. Based on these factors, we recommend that this watershed be a lower priority for stormwater management at this time.

COUNTY-WIDE STORMWATER MANAGEMENT RECOMMENDATIONS

Effective management of stormwater benefits our water supplies, protects property, and supports critical natural resource areas such as wetlands and streams, and the species dependent on them. Effective stormwater management means protective stormwater management that is also cost effective.

In San Juan County, the dominant land use is residential development (37 percent) followed by almost equal areas of undeveloped land and water (26 percent) and resource production and extraction (farming and forestry) (24 percent). These statistics are telling and lay the framework for the opportunities and challenges we face managing stormwater in San Juan County.

Given the existing predominantly rural and semi-rural character of our island landscapes, we have a greater opportunity to provide long-term protection for high value water resources affected by stormwater management than more urbanized communities do. However, most of the development occurring in San Juan County is small, residential, and falls below the current regulatory thresholds for required stormwater treatment or flow control. In comparison to other types of high-use development (such as commercial or industrial), small and residential scale development is generally expected to produce fewer stormwater related problems. However, even though much of this development falls below existing regulatory thresholds for San Juan County, the cumulative effects of these land uses can still add to the County's stormwater problems. Even low-density development without treatment and flow control contributes to an ongoing challenge: continuing aggregate increases in stormwater flows and the consequent strain on both constructed and natural stormwater, wetland, and stream systems. This cumulative effect defines the problem of unmanaged stormwater.

Adding to the challenge of unmanaged stormwater is that incoming development is the focus of regulation; however, existing development may be having a far more serious impact on property and the environment. The frequent flooding problems in Eastsound testify to that issue as the vast majority of development has occurred under less stringent stormwater management standards than would be implemented today. Jurisdictions large enough to be covered under an NPDES permit can require improvements to stormwater flow control and treatment when redevelopment occurs but San Juan County falls below this federal regulatory threshold. Consequently, opportunities to ensure that existing and future development in the County properly manage stormwater are currently limited, will likely need to rely heavily on voluntary participation, at least in the short term, and improvements will be fueled more by community outreach, education, training, and partnerships rather than by regulation. Research has shown these strategies can be quite successful (Nowacek et al. 2003).

Regulation-based alternatives to addressing the problem of unmanaged stormwater could include the County voluntarily entering the NPDES program or it could develop its own

regulations that more effectively address the range of development conditions we see in San Juan County. The County may also be eligible for grants that could fund retrofits of stormwater management systems in problem basins and systematically fix the problems produced by historical development.

The following Countywide recommendations are provided as potential strategies to further the goal of countywide effective and protective stormwater management.

Develop Basin Plans for Priority Watersheds

In some areas of the County, development and growth has increased local flooding due to past drainage practices (G. Bronn, Engineer, Hart Pacific Engineering, personal communication, April 8, 2014), and we can reasonably expect property owners along these drainages to be further impacted by flooding and loss of developable property in the future as additional land is developed. In contrast, other nearby wetlands and drainages may have capacity and could benefit from more stormwater flow. Because stormwater management is determined on a project-by-project basis without benefit of a landscape-level understanding of water flow and watershed conditions, there is currently no avenue for watershed-based stormwater management solutions that could relieve stormwater pressure in some areas of a watershed while accommodating it in others. Developing watershed-specific basin plans would help provide that context. This report provides an overview of County stormwater issues as well as key characteristics of its watersheds and provides much of the context required to begin detailed basin planning that would take into account landscape character and resources.

The next step would be to identify the watershed landscape's natural capacity and limitations for effectively managing stormwater. Critical drainage pathways, especially where flooding problems have been reported, could be evaluated to determine what hydraulic capacity there might be for added flow that would still be protective of biological resources. This would require the development of hydrologic models to facilitate understanding of each watershed studied. Such watershed-specific studies would guide the selection of solutions within the basin and identify projects that should be constructed, and property or drainage easements that should be acquired for the benefit of watershed residents. Specific watershed studies could also identify whether onsite detention and treatment system requirements and impervious surface percent limitations should apply at thresholds that are more stringent for particular watersheds.

Basin planning was completed for Lopez Village and Eastsound in 2005. These basin plans will be updated with recommendations for capital improvement projects in Volume 2 of this report. Recommendations will be provided for other County watersheds with high value ecological resources or serious flooding concerns in Volume 2 as well. Watersheds currently identified for further analysis in Volume 2 of this report are Garrison and False Bay on San Juan Island, Mud Bay and Fisherman Bay on Lopez, and the watershed containing the town of Eastsound on Orcas.

Minimize Impervious Cover and Maximize Infiltration

Conventional stormwater management typically conveys stormwater away from a built site, across pavement to a gutter or drain and into a pipe system that delivers the stormwater to

a local waterbody. From a community perspective, each development project that includes impervious cover and ties into the public stormwater system contributes to the potential for water resource impairments and the cost of maintaining public infrastructure. Communities can reduce the harmful effects of impervious cover in several ways, including avoiding constructing it, disconnecting it from the stormwater infrastructure system, reducing its dimensions, and using alternative pavements. Many of these principles underlie the use of low impact development practices.

San Juan County has overall low impervious cover (Table 2). The highest percent of impervious cover in a watershed occurs in the North Shore of Orcas (which includes most of Eastsound) at 10.2 percent, followed by Friday Harbor at 9.5 percent, and Roche Harbor at 9.0 percent. Virtually all other watersheds have less than 5 percent impervious cover. Research generally indicates that stream quality varies based on watershed impervious cover. Most notably, at between 5 and 10 percent impervious cover, sensitive stream elements are lost from the system and include diminished aquatic diversity and water quality (CWP 2003; May et al. 1997). This evidence suggests that watersheds with urban areas such as Friday Harbor, Eastsound, and Roche Harbor are at greatest risk for stormwater caused degradation of water resources. Impervious area in most other watersheds remains below the 5 percent threshold and is not yet, in most cases, a significant stressor to stream and wetland conditions in San Juan County. The high area of currently undeveloped land and large area of resource lands in the County works to benefit stormwater management efforts in that it reduces stormwater infrastructure needs and maintenance costs.

However, coastal communities such as ours often rely on their location for economic vitality through fishing, tourism, and water dependent activities. In addition, shorelines are scenic and desirable places for people to live. Most of the urban areas and concentrated development occurs along shorelines in San Juan County; examples are Eastsound, Roche Harbor, Lopez Village, and Olga. Moreover, owners of residential shoreline property most always construct their homes near to the shore. Consequently, the marine shoreline areas of our watersheds tend to have higher impervious cover than inland watershed areas. Higher impervious area combined with potentially poor stormwater management in shoreline areas can further compound flooding threats to property and resources from large storms where stormwater flows combine with wave energy to cause damage; this threat will increase in severity with ongoing sea level rise. In addition, there is little area to provide for attenuation of flows or water quality treatment in the shoreline. Thus, stormwater runoff typically flows directly to marine waters without flow control or water quality treatment.

Although the entire watershed can benefit from improving stormwater management, it is imperative that shoreline development use integrated approaches to stormwater management due to the potential harm that storms can cause to public health, property, and environmental resources. In addition, some shoreline properties require careful stormwater analysis because they are in small basins and have unstable bluffs that produce erosion hazards not captured by our databases. For new development, these issues could be addressed through development standards that specifically apply to properties within the County's regulatory shoreline jurisdiction. For existing development, public outreach and education may be most effective.

The County's reliance on groundwater as the primary source of fresh water also has implications for promoting infiltration of stormwater. Because the many aquifers in the County are recharged by the infiltration of precipitation, land use and stormwater management practices that affect runoff, infiltration, and pollutant loading can affect the quality of groundwater resources. Runoff and infiltration rates on steep topography underlain by thin soils or sedimentary deposits on shallow bedrock typical of many of the County's watersheds may be more sensitive to changes in land use and vegetative cover than gently sloping topography underlain by a thick sequence of sedimentary deposits. Likewise, the low water-bearing capacity of the many bedrock aquifers may not buffer water quality impacts from pollutant loading related to roads, and commercial and residential areas. Thus, an understanding of the hydrogeology of the County is important for assessing which areas are more sensitive to various land-use practices and stormwater management alternatives. Careful management of stormwater to promote infiltration and maintain high surface and groundwater quality is essential.

Retrofit Ditches and Ponds

Ditches are the primary stormwater conveyance in San Juan County. Poorly designed ditches can increase stormwater flow velocity, which causes erosion and subsequent sedimentation that can adversely affect downstream waterbodies. Orcas and San Juan islands, in particular, have many narrow steep ditches that continuously erode sending sediment downstream. The standard size of ditches has historically been 12-inches-wide by 12-inches-deep. Altering ditches to be wider and flatter would significantly their improve water quality treatment functions and they could be altered to slow flows as well. Trees and rock outcroppings also restrict ditch size and placement in many areas. As with many of the issues discussed here, these problem ditches often occur on private property limiting the County's ability to address them. Even on public roads, there are areas where the County does not own sufficient right of way to accommodate wider ditches. Nevertheless, where possible, retrofitting ditches to be wider and flatter would significantly improve the water quality treatment they provide.

However, ponds also allow for higher rates of evaporation, have low plant diversity, which substantially reduces their water quality treatment effectiveness, and they can affect both the timing and volume of instream flows in County creeks. These issues could be improved through strategic purchases of land or drainage easements that would allow the County to retrofit ditches or ponds to improve stormwater treatment and flow conditions within the broader landscape.

Ponds proliferate across the San Juan County landscape, and in many areas, ponds have replaced historical wetlands. They are used for recreation and many are important for irrigation and livestock watering. Ponds can be beneficial in that they may act as detention ponds in the landscape slowing stormwater flows and capturing sediment along with other pollutants. However, ponds also allow for higher rates of evaporation during the dry season than wetlands typically would, which can deplete local aquifers. Ponds generally have far lower plant diversity than natural wetlands, which substantially reduces their water quality treatment effectiveness. Moreover, many ponds in our County have significantly affected both the timing and volume of instream flows in County streams. This is because some ponds are designed such that they operate like bathtubs within a stream system, requiring they be filled

before water passes downstream, as illustrated in Figure 132. This has the effect of delaying fish spawning into later fall than under historical conditions and may be directly affecting the viability of historical salmon runs. Reduced and delayed instream flows can directly affect the viability of many aquatic species.

These issues could be improved through strategic purchases of land or drainage easements that would allow the County to alter ponds located in important drainages where a retrofit could reduce flooding, and improve water quality or degraded instream flows, thus benefiting critical areas and protected species. Retrofits would allow some water to pass through an instream pond to allow more downstream flow.

Maximize Use of Existing Ecological Systems

Use of natural systems such as existing wetlands, ponds, streams, swales, and ditches for stormwater management can effectively keep the public cost of stormwater management low. All of the watersheds reviewed for this study have some combination of these water features along drainage flow paths to the sea and they play key roles in providing water quality treatment and flow control. Connecting wetlands, swales, and ditches in a network of small-scale features would allow flow reduction, water treatment, and habitat support to occur throughout a given watershed rather than at the bottom or just prior to discharge into a large receiving water body; this could be especially effective in agricultural areas.

Moreover, based on water quality sampling results, water quality degradation in the County is primarily due to exceedances of water quality standards or guidelines for bacteria and nutrient, rather than high levels of heavy metals or toxic chemicals. Wetlands and swales are naturally effective treatment environments for bacteria and nutrients. Maximizing the use of existing natural systems would be an effective and low cost way to improve the water quality issues of greatest concern in San Juan County.

Use of natural systems for stormwater management would require careful assessment and monitoring to ensure that degradation is not occurring. This could be accomplished within the context of a basin plan that identified opportunities to solve stormwater problems by identifying the capacity of natural systems within the basin to accommodate additional stormwater both from flow and water quality perspectives. Flow and water quality could be monitored with automatic data loggers and the data periodically analyzed to ensure results are within protective thresholds. This approach would best be implemented using an adaptive management approach where contingency measures would be identified in advance and then executed should protective thresholds be exceeded.

Acquire Property or Easements to Reduce Impacts on Property Owners and the Environment

Drainage solutions identified from basin planning efforts may point to acquiring property or drainage easements on private property for improved stormwater management. Drainage easements would allow for retrofits on existing infrastructure such as improved drainage ditch design or alterations to ponds that improve water quality treatment characteristics. Drainage easements would allow for County control over stormwater where needed to protect property

from flooding or losses to critical area resources from increased frequency of high stormwater flows. This strategy has historical roots in the ditch districts, for example one was present in San Juan Valley on San Juan Island, that managed water flow to allow for safe and effective farming, protected against flooding, and provided water to agricultural operations where needed.

The prospect of drainage easements may interest potential partners including conservation organizations such as the San Juan County Land Bank, which carries protection of potable water in its mandate. If a public amenity such as a trail were added as an element of a drainage easement, that may also draw interest, support, and funding from local island trail groups such as San Juan Trails Committee and Lopez Community Trails Network. Public private partnerships with these and similar organizations could be a vehicle for retrofitting ponds, enhancing wetlands, improving stormwater management, and increasing community trail opportunities.

Increase Public Outreach and Education Efforts

Because most land development in the County is for single-family residential housing, proactive outreach to new and existing residential property owners is recommended. Research has shown public outreach and education can successfully change owner behavior (Nowacek et al. 2003). Outreach programs could include education, training, and technical assistance on best practices for managing onsite stormwater, pond development, herbicide and pesticide use, home maintenance chemicals, agricultural operations, forestry practices, and animal waste control. Many of these suggested outreach efforts would have logical partners in the San Juan County Health Department (which successfully handles training for onsite septic system inspection and maintenance) and San Juan Islands Conservation District (which already offers workshops on low impact development stormwater management practices). Certain of these efforts may qualify for grant funding, particularly fencing assistance to farmers and pond retrofits that improve instream flows for salmon.

Support Neighborhood-Based Stormwater Management Solutions

Measures that encourage stormwater projects sponsored by neighborhood groups and communities could provide innovative implementation of stormwater management solutions. The County would offer technical assistance and potentially some funding to assist communities in solving local stormwater management problems in ways that are cost effective and meet local needs. Neighborhood-based solutions could produce creative projects that provide multiple benefits to the neighborhood such as a constructed wetland for flood control and treatment that also has a neighborhood trail and meeting area. Projects may be driven by the desire to protect a critical natural resource, restore a drainage network, or a trailblazing neighborhood may wish to solve ongoing flooding problems using environmentally sustainable solutions. Areas of the County with a high percentage of private roads constructed without common standards, and with ongoing flooding problems are good candidates for this type of support; an example would be the Rosario neighborhood on Orcas Island. Innovation can be a bumpy road but conditions that encourage the broad community to learn about more effective stormwater management with the help of technical experts are likely to be successful. Developing private public partnerships that support citizens voluntarily

solving their stormwater problems will allow for more innovative solutions and help move a community forward faster.

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FIGURES



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1 in = 2 miles

Miles

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Figure 1:

Study Area for San Juan County Stormwater Basin Planning Project

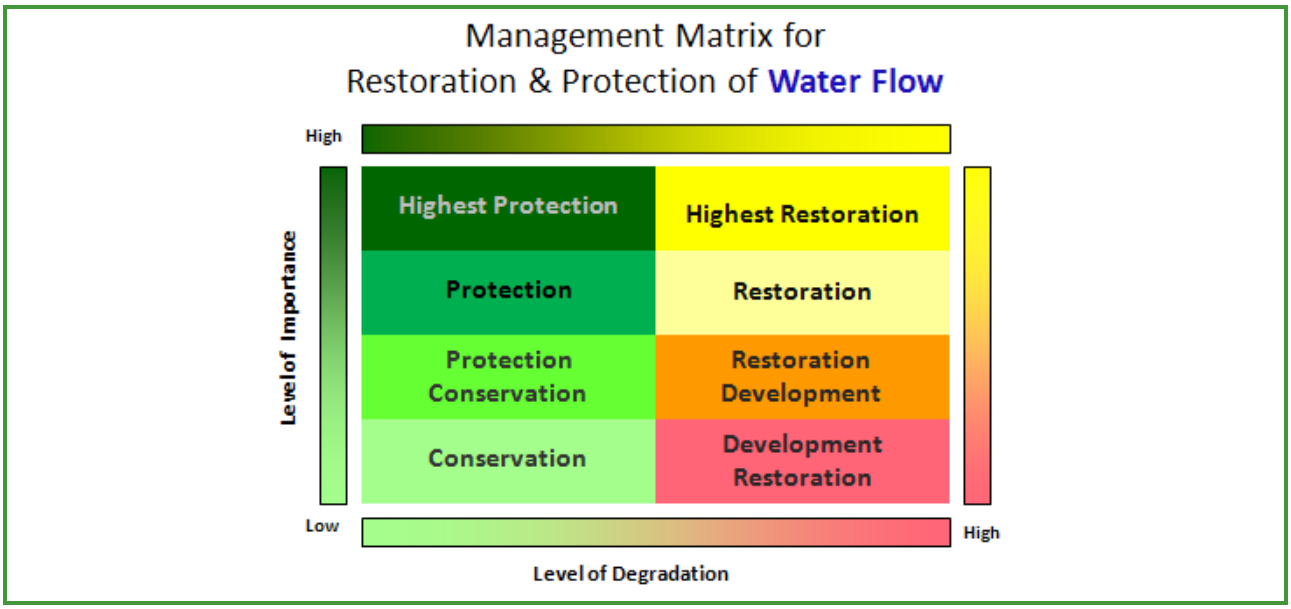


Figure 2. Puget Sound Watershed Characterization Management Strategy Matrix.



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Figure 3:

Puget Sound Watershed Characterization Water Flow Assessment Results for San Juan County

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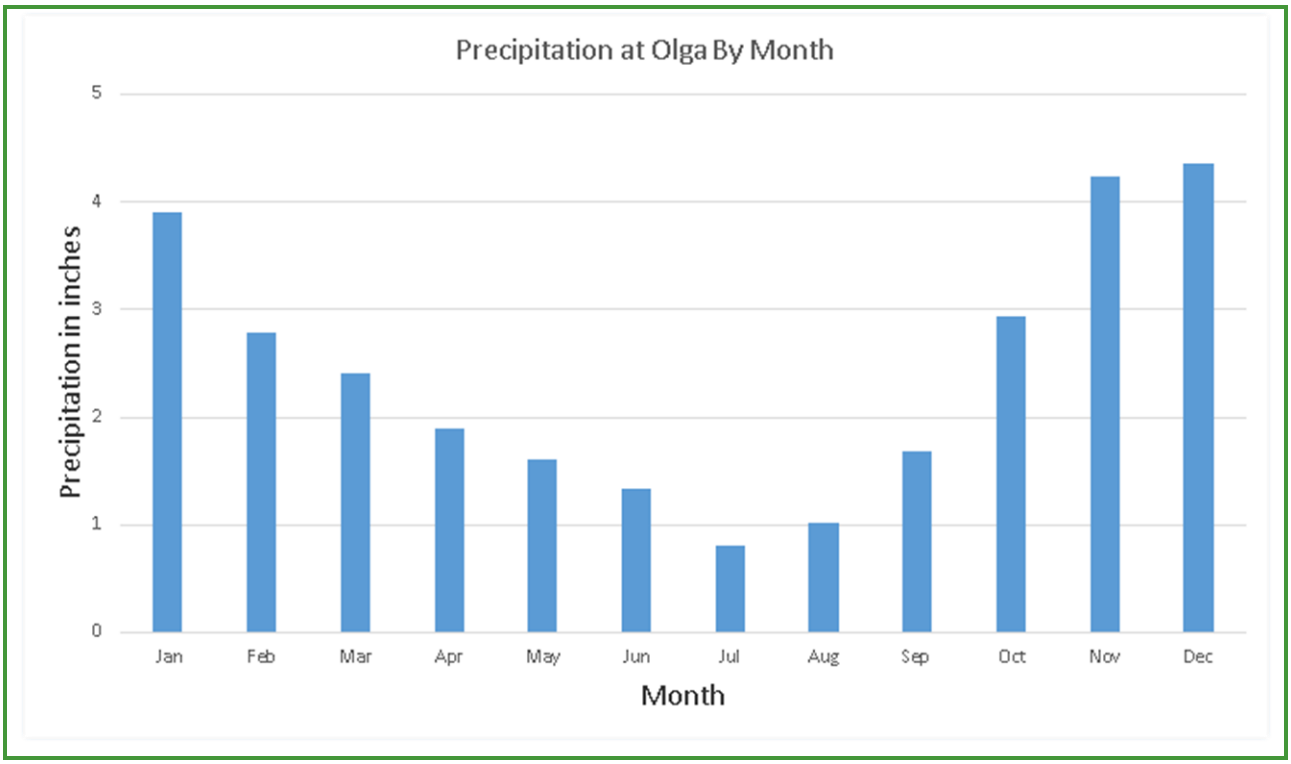


Figure 4. Precipitation Measured at the Olga Weather Station by Month.



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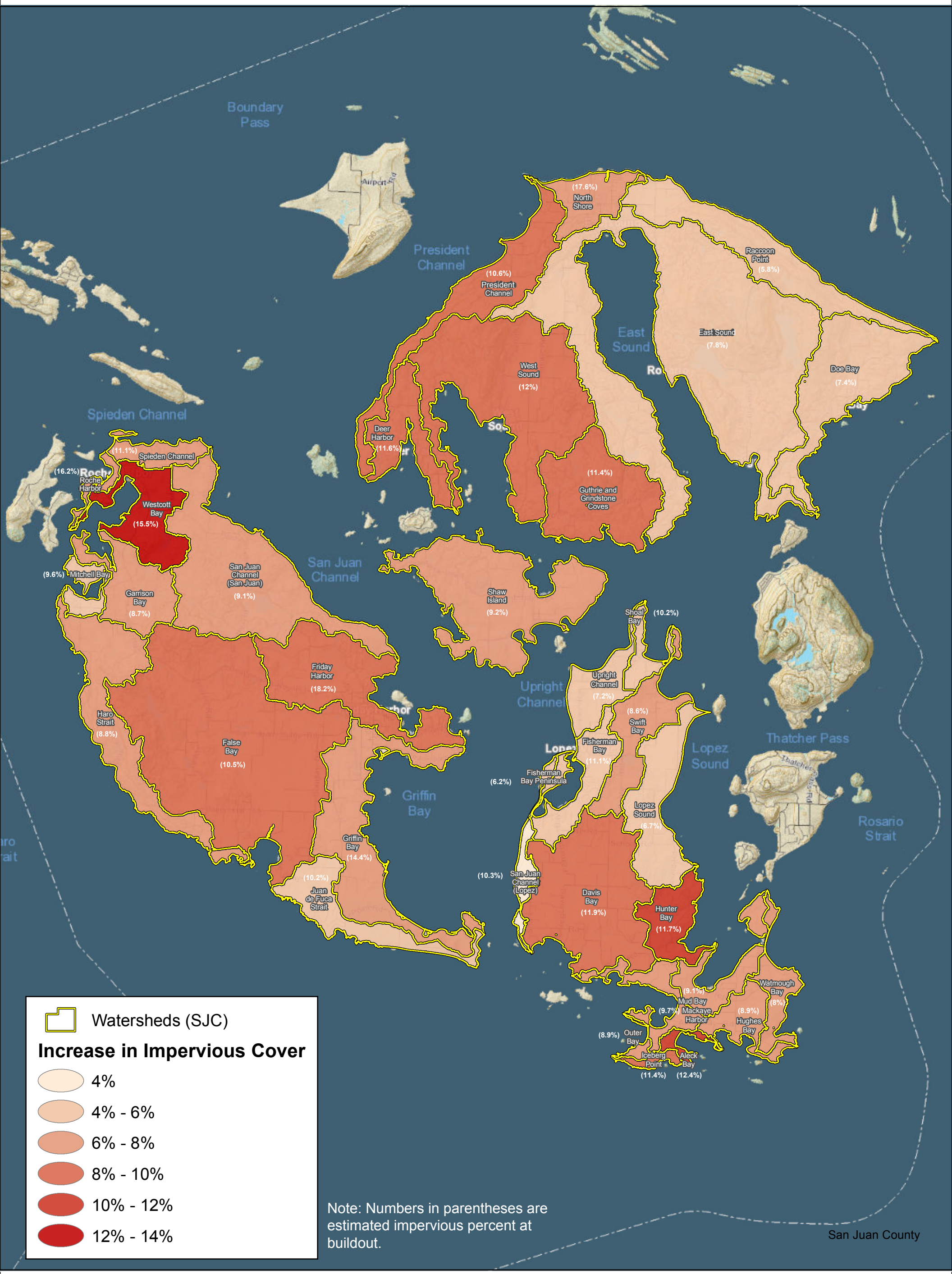
Figure 5:
Coastal Bluff Stability of the San Juan Islands

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Figure 6:

Percent Increase in Impervious Cover from Existing to Estimated Buildout Conditions

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Buildout - Increase in Impervious Cover.mxd

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Date: 6/4/2014

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Boundary Pass
President Channel
Spieden Channel
San Juan Channel
Griffin Bay
Upright Channel
East Sound
Lopez Sound
Rosario Strait
Thatcher Pass
North Shore Orcas
President Channel
Raccoon Point
East Sound
West Sound
Doe Bay
Deer Harbor
G&G Coves
Roche Harbor
Westcott Bay
Mitchell Bay
Garrison Bay
San Juan Channel (San Juan)
Friday Harbor
Haro Strait
False Bay
Griffin Bay
Juan de Fuca Strait
Shoal Bay
Upright Channel
Swift Bay
Fishermans Bay
Penn Bay
Lopez Sound
San Juan Channel (Lopez)
Davis Bay
Hunter Bay
Mud Bay
Watmough Bay
Mackaye Harbor
Hughes Bay
Outer Bay
Iceberg Point

- Extent of 24K Geologic Mapping
- Watersheds (SJC)

Geologic Units

- Recent
- Sumas and Vashon Rec. deposits, sandy
- Undifferentiated deposits
- Everson and Vashon, fine-grained
- Vashon advance outwash
- Pre-Vashon deposits undifferentiated
- Bedrock
- Landslide deposits

Washington State Department of Natural Resources, San Juan County

SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2 miles

0 1 2 Miles

Figure 7:

Selected Geologic Units within San Juan County

Countywide geological mapping at 1:100,000 scale. Portions of mapping were completed at 1:24,000 scale.

Path: \\Gisserver\gis\Projects\Stormwater Outreach\SW Basin Planning\Maps\Selected Geologic Units.mxd

Drawn By: Nick Peihl

Date: 4/25/2014

Time: 8:45:09 AM

Boundary Pass
President Channel
Spieden Channel
San Juan Channel
Griffin Bay
Upright Channe
Lopez Sound
Thatcher Pass
Rosario Strait
East Sound
Roche Harbor
Westcott Bay
Mitchell Bay
Garrison Bay
San Juan Channel (San Juan)
Friday Harbor
Haro Strait
False Bay
Juan de Fuca Strait
Deer Harbor
West Sound
North Shore
President Channel
Raccoon Point
East Sound
Doe Bay
Guthrie and Grindstone Coves
Shoal Bay
Upright Channel
Swift Bay
Fisherman Bay
Fisherman Bay Peninsula
Lopez Sound
San Juan Channel (Lopez)
Davis Bay
Hunter Bay
Mud Bay
Watmough Bay
Mackaye Harbor
Hughes Bay
Outer Bay
Iceberg Point

- Watersheds (SJC)
- High Infiltration Rates
- Moderate Infiltration Rates
- Low Infiltration Rates
- Very Slow Infiltration Rates
- Soils with Low Infiltration Feasibility
- Infiltration Not Feasible

Natural Resources Conservation Service, San Juan County

SAN JUAN COUNTY WASHINGTON

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1 in = 2 miles

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Figure 8:
Hydrologic Soil Groups of San Juan County, from Natural Resources Conservation Service

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Drawn By: Nick Peihl

Date: 4/29/2014

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SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

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Figure 9:

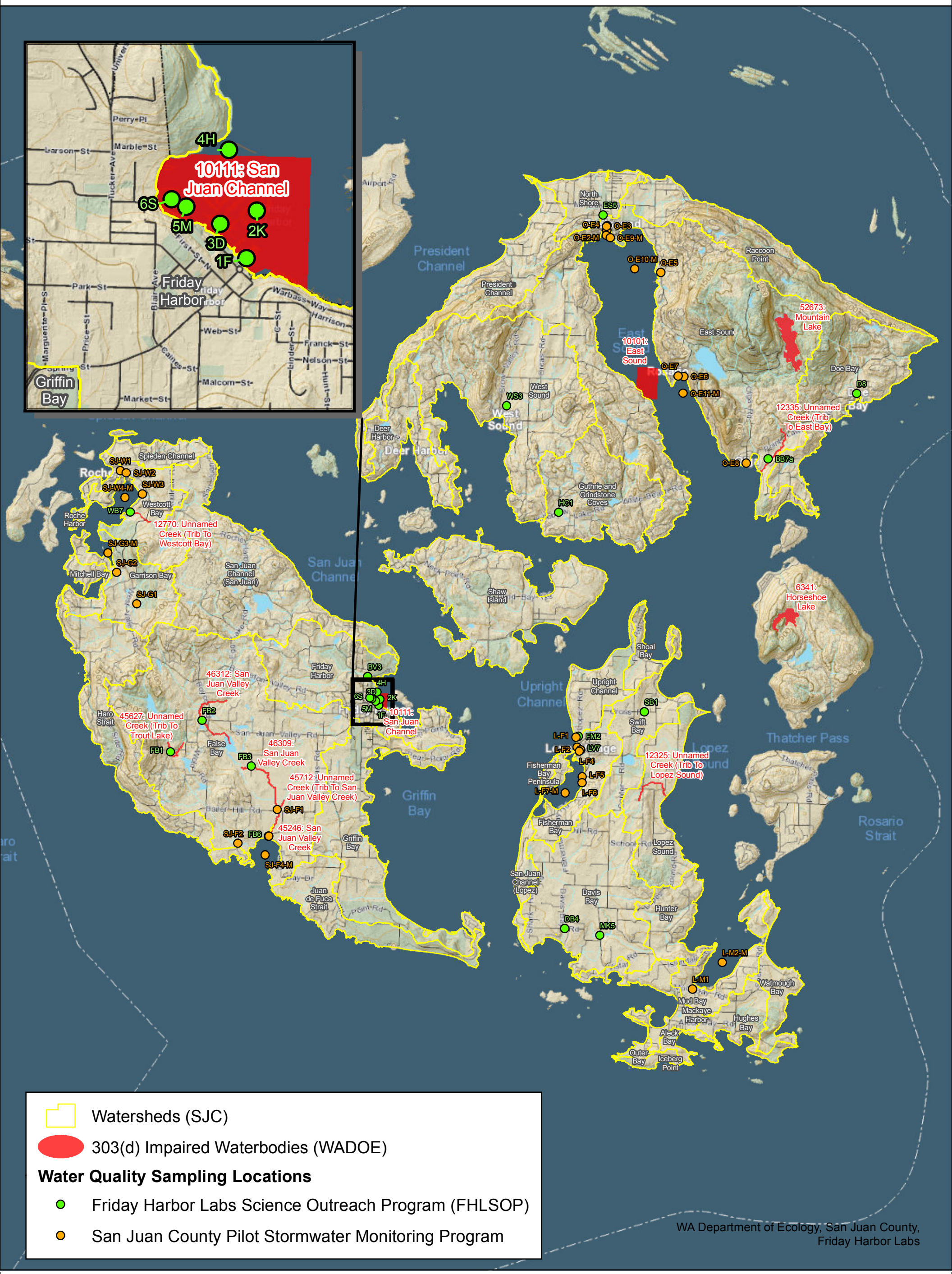
Overlay of Selected Geology with Hydrologic Soils Groups A and B

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Date: 4/29/2014

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SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

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Figure 10:

Map of Ecology 2012 303(d) Impaired Waterbodies and Water Quality Sampling Locations in San Juan County

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\San Juan 303(d) Water Bodies.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 9:44:17 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 3,400 feet

0 1,200 2,400 3,600 Feet

Figure 11:
Overview of False Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:11 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,500 feet

Feet
0 1,200

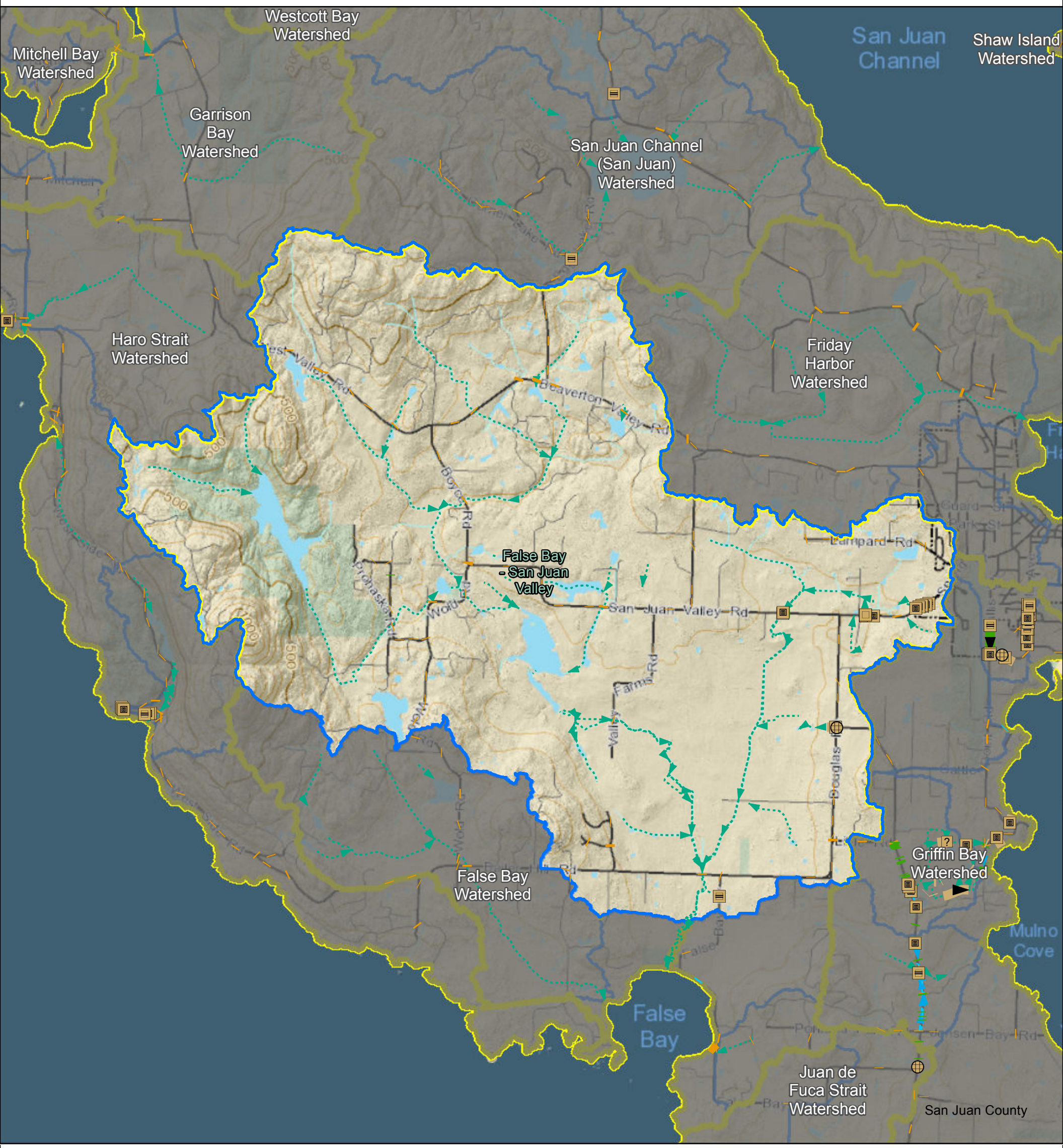
Figure 12:
False Bay Watershed Basin 1
Wold Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

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This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

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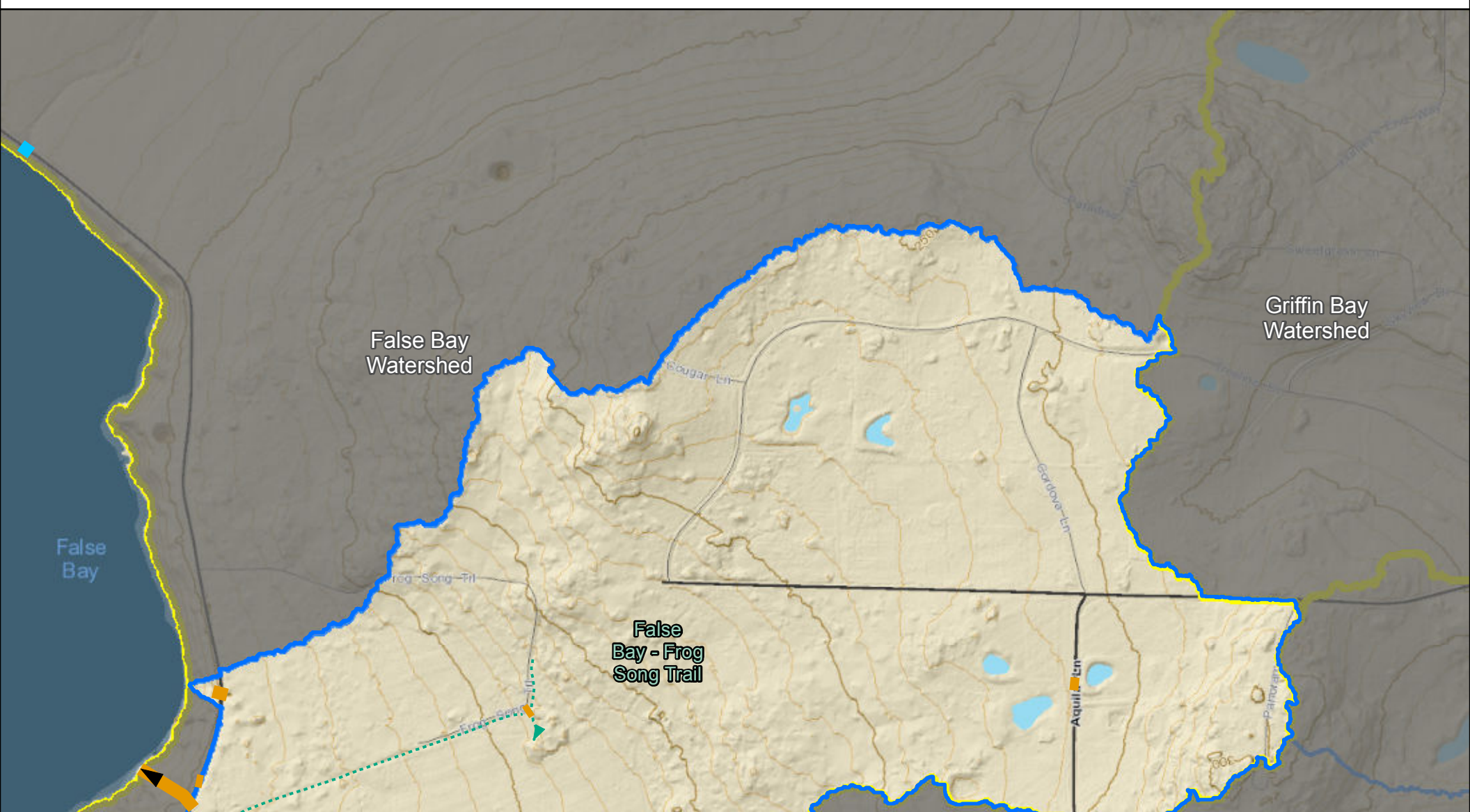
Figure 13:
False Bay Watershed Basin 2
San Juan Valley

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

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Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

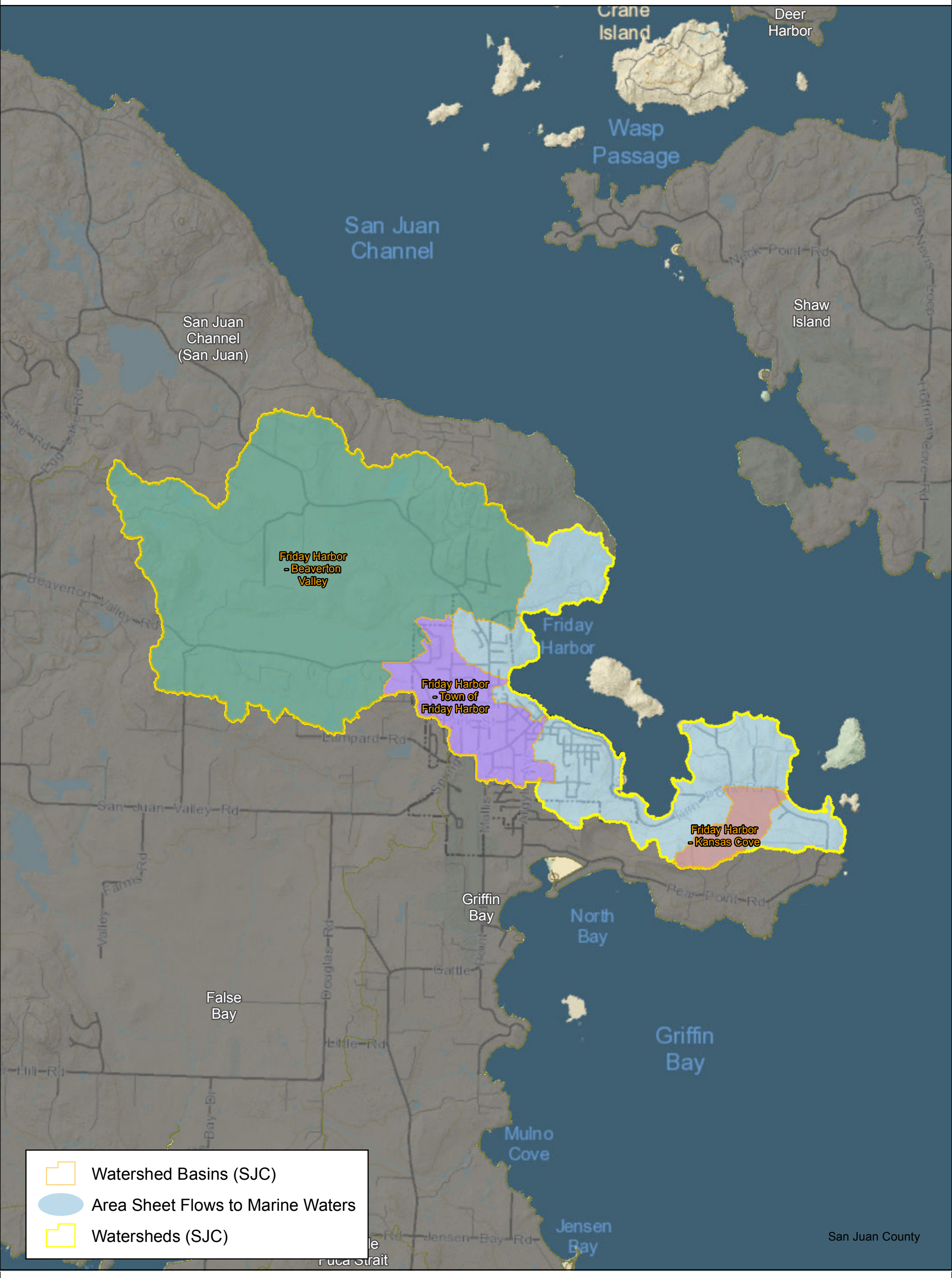
This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

Figure 14:
False Bay Watershed Basin 3
Frog Song Trail

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd Drawn By: Nick Peihl Date: 6/3/2014 Time: 11:05:59 AM



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1 in = 3,000 feet

Feet
0 1,200 2,400 3,600

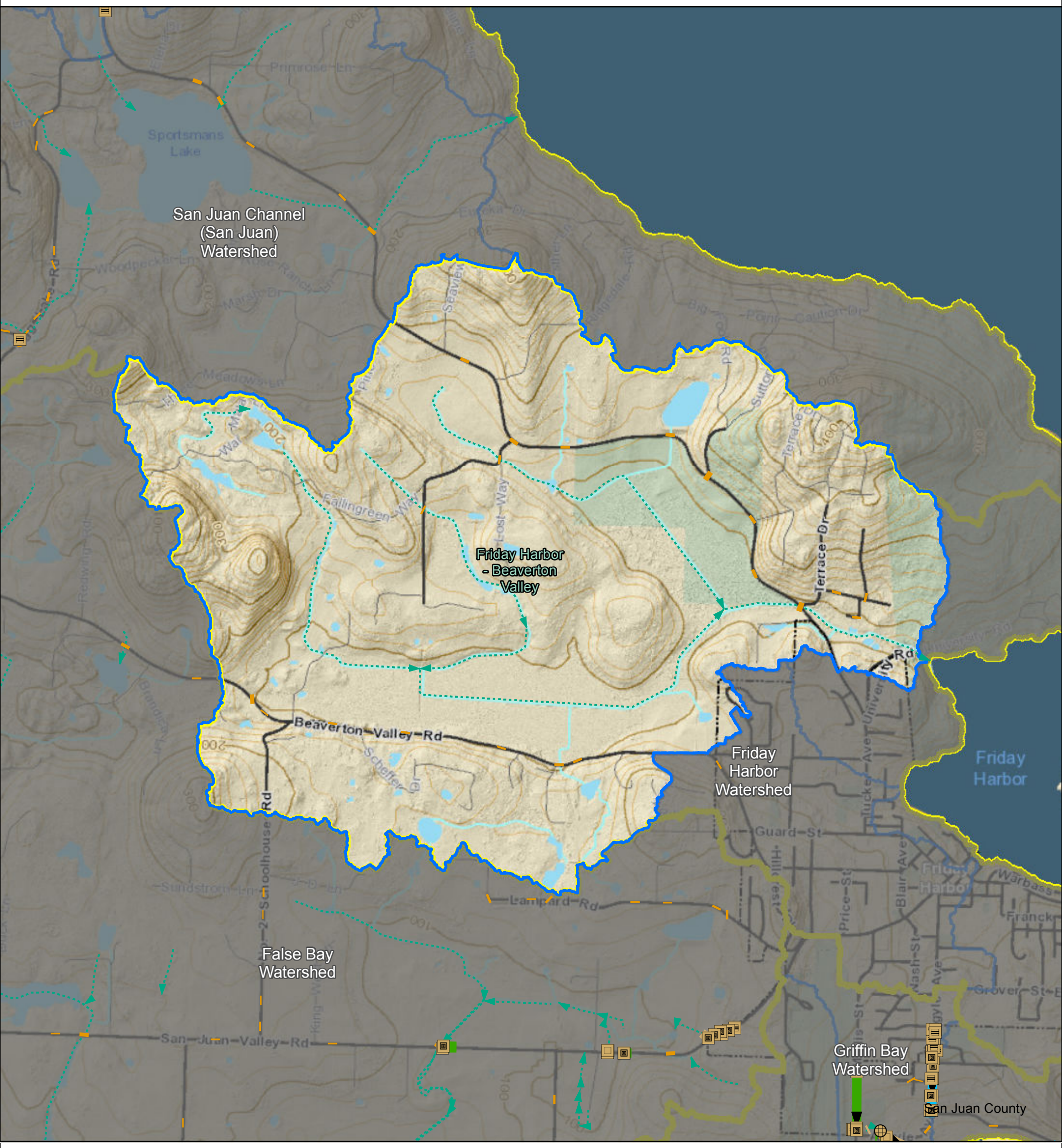
Figure 15:
Overview of Friday Harbor Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:14 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,700 feet

Feet
0 1,200

Figure 16:
Friday Harbor Watershed Basin 1
Beaverton Valley

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:05 AM



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1 in = 700 feet

0 — 920 Feet

Figure 17:

Friday Harbor Watershed Basin 2
Town of Friday Harbor

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:11 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 400 feet

0 Feet 520

Figure 18:
Friday Harbor Watershed Basin 3
Kansas Cove

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:16 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,600 feet

Feet
0 1,200

Figure 19:
Overview of Garrison Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:18 AM



SAN JUAN COUNTY WASHINGTON

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1 in = 1,200 feet

0 Feet 1,200

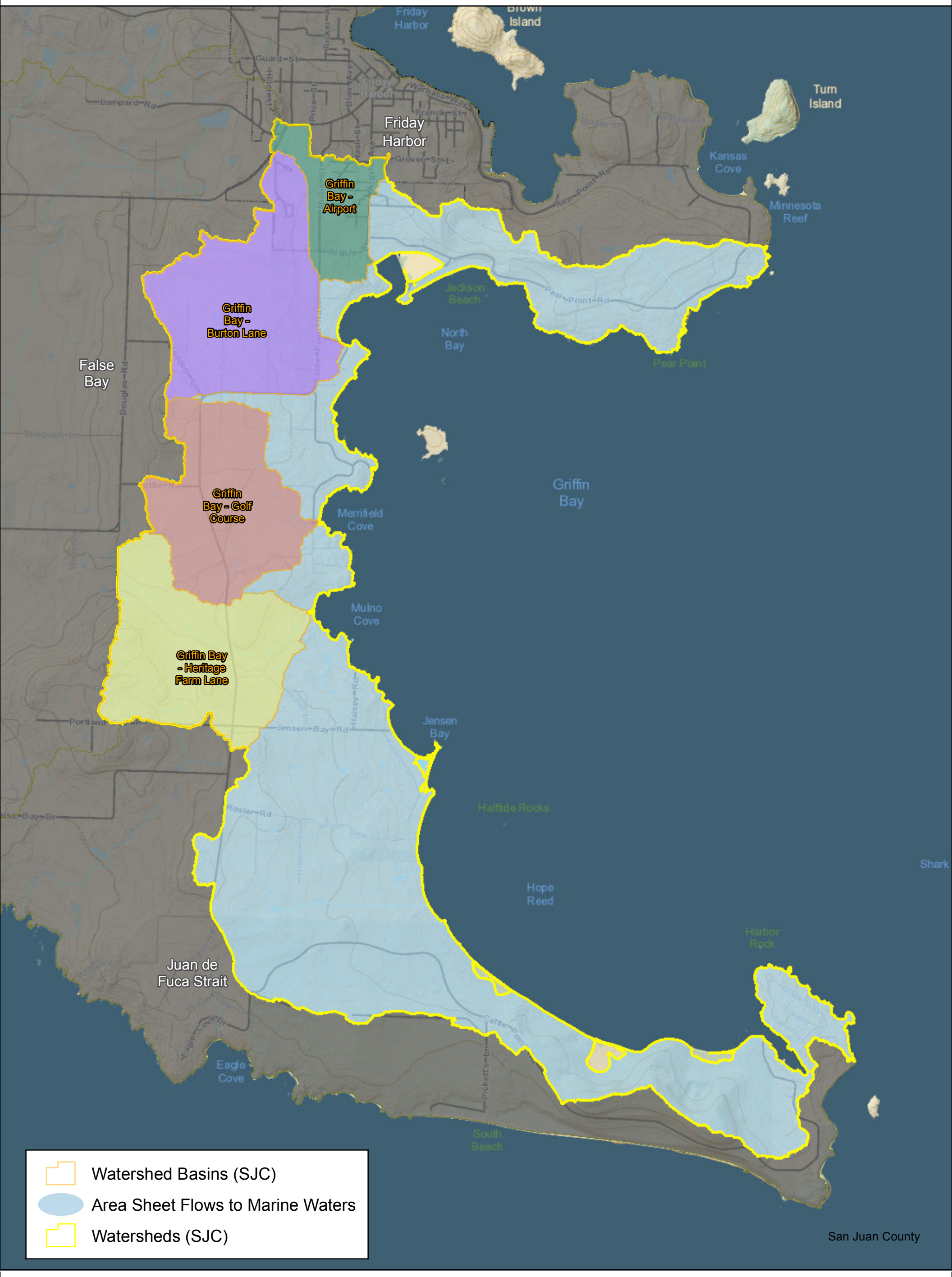
Figure 20:
Garrison Bay Watershed Basin 1
West Valley Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:24 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,400 feet

0 1,200 2,400 Feet

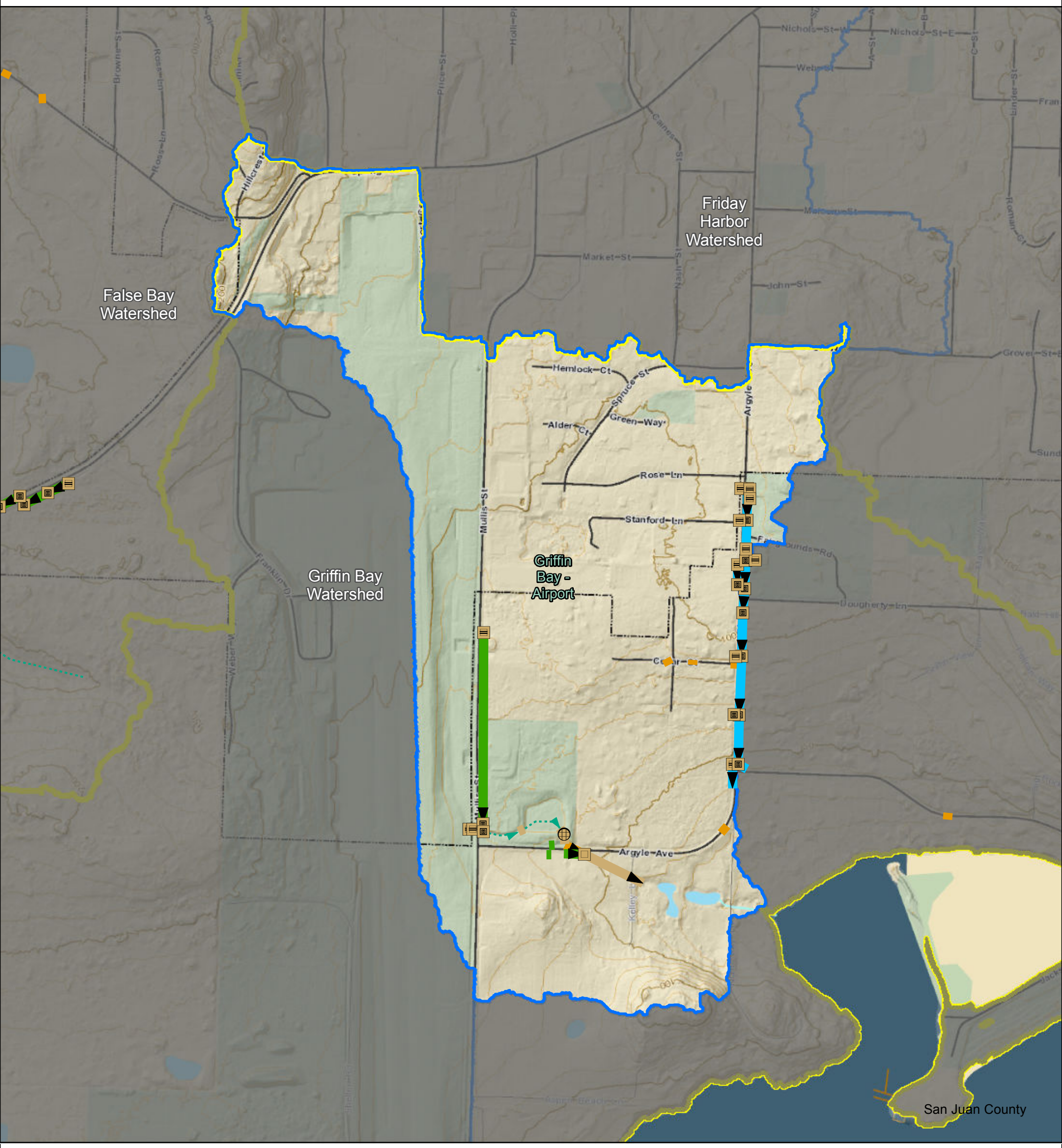
Figure 21:
Overview of Griffin Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:21 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

Figure 22:

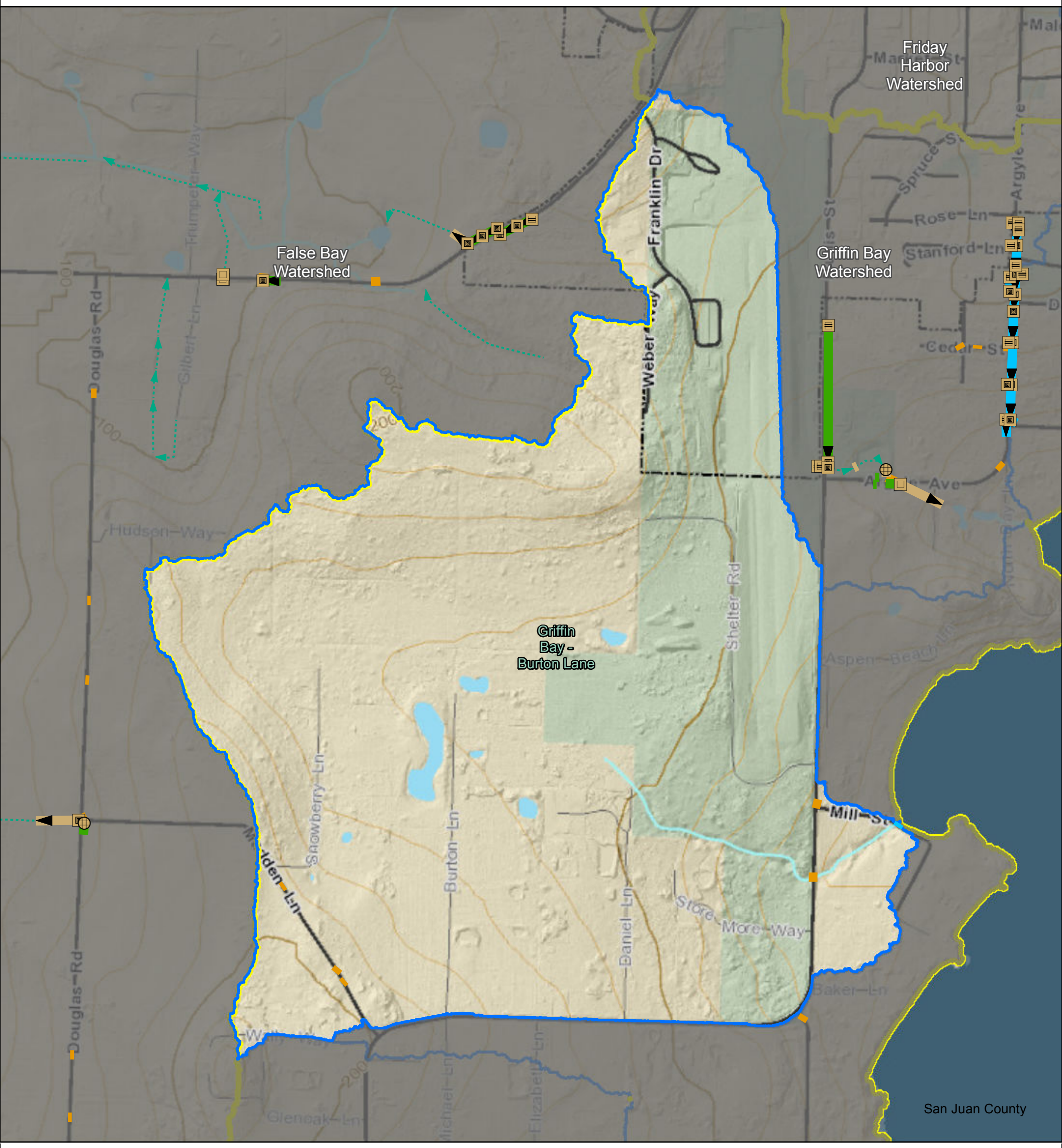
Griffin Bay Watershed Basin 1 Airport

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:30 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 — Feet — 920

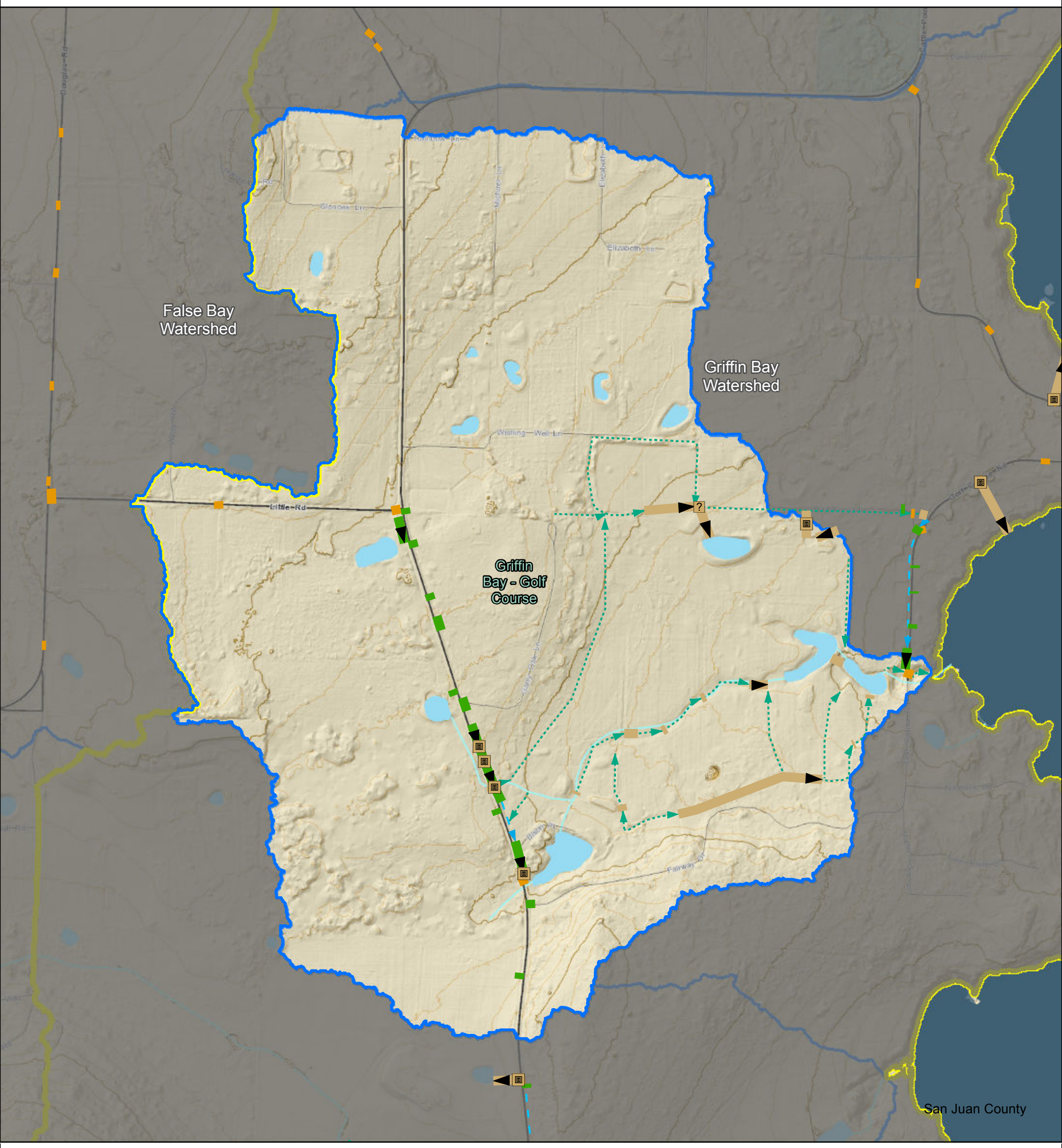
Figure 23:
Griffin Bay Watershed Basin 2
Burton Lane

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:35 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 780 Feet

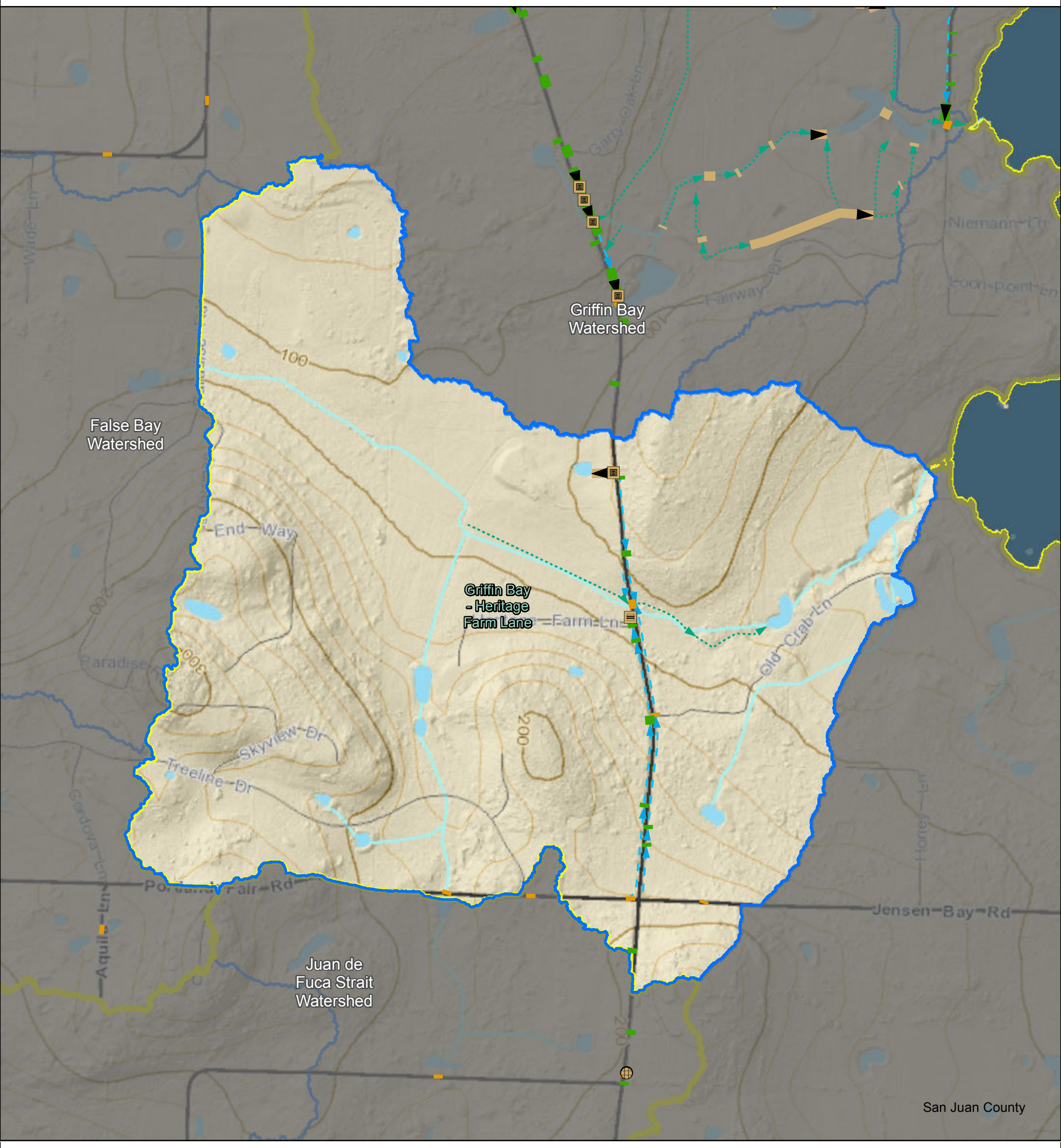
Figure 24:
Griffin Bay Watershed Basin 3
Golf Course

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:41 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 — Feet — 920

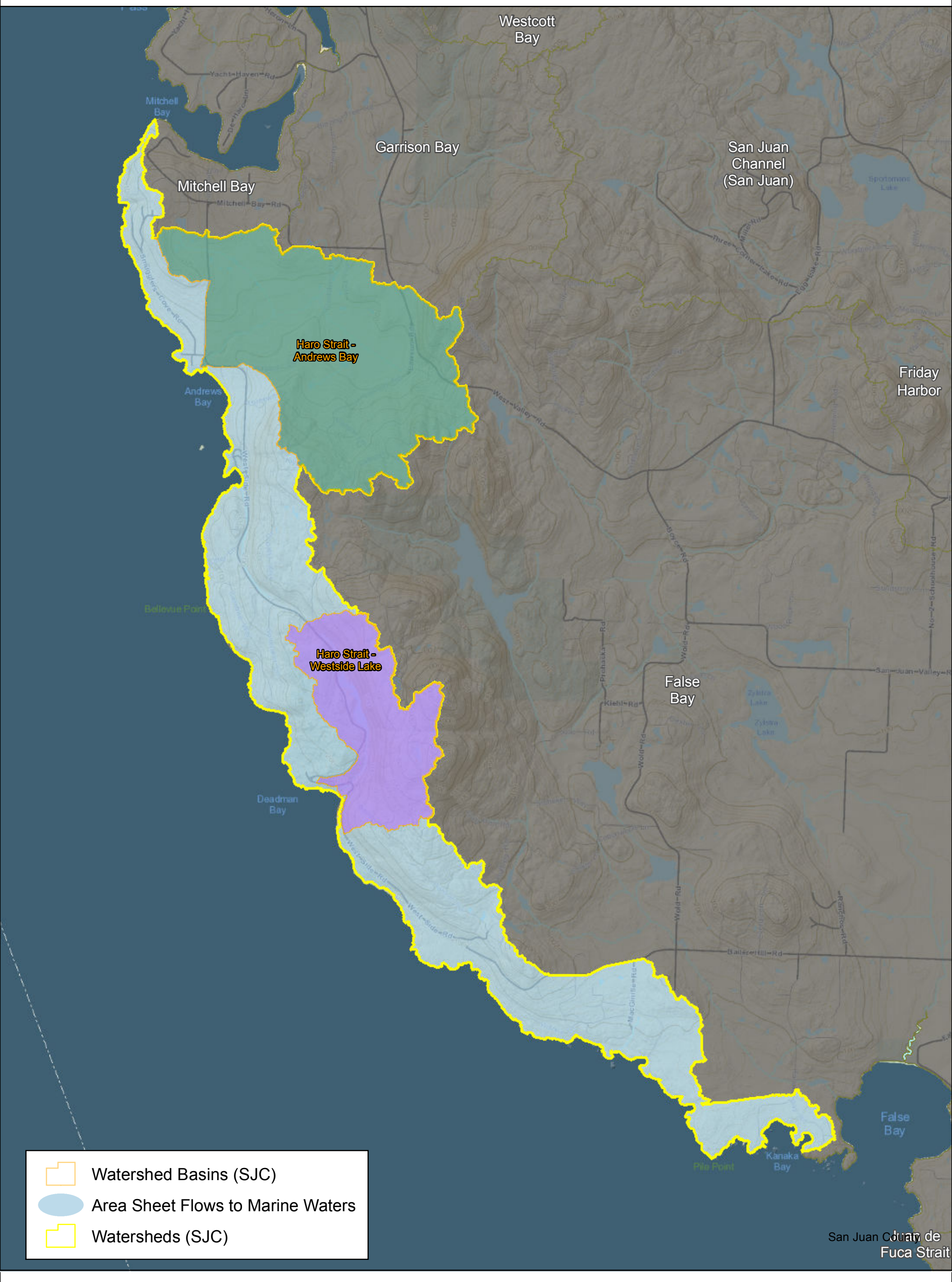
Figure 25:
Griffin Bay Watershed Basin 4
Heritage Farm Lane

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:46 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,800 feet

Feet
0 1,200 2,400 3,600

Figure 26:
Overview of Haro Strait Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:24 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,200 feet

0 — 1,200 Feet

Figure 27:
Haro Strait Watershed Basin 1
Andrews Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:51 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 1,000 Feet

Figure 28:

Haro Strait Watershed Basin 2
Westside Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:06:56 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 3,000 feet

Feet
0 1,200 2,400 3,600

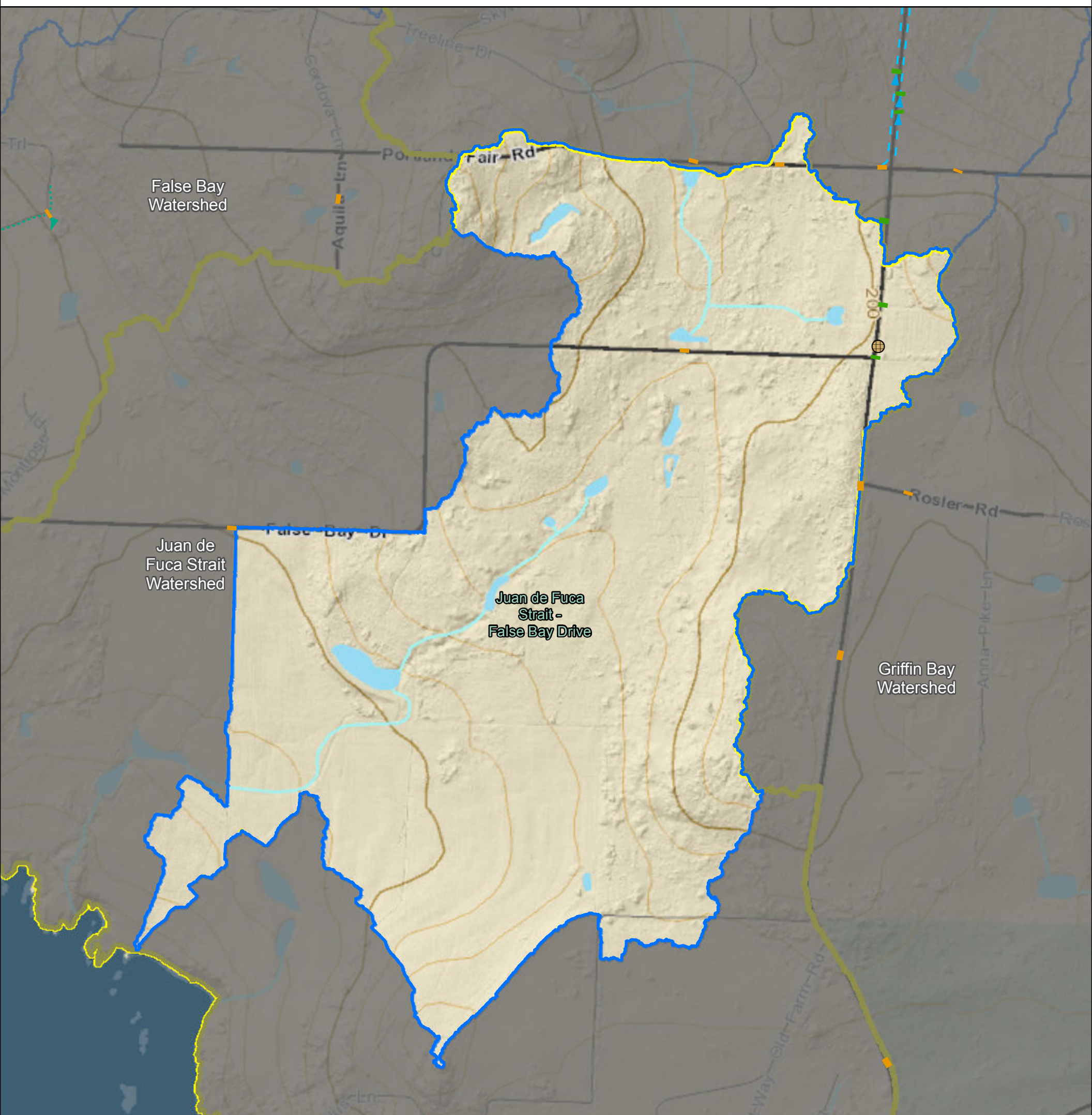
Figure 29:
Overview of Juan de Fuca Strait Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:27 AM



- Watershed Basins (SJC)
- Watersheds (SJC)
- Stormwater Flowlines
- Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 — 920 Feet

Figure 30:

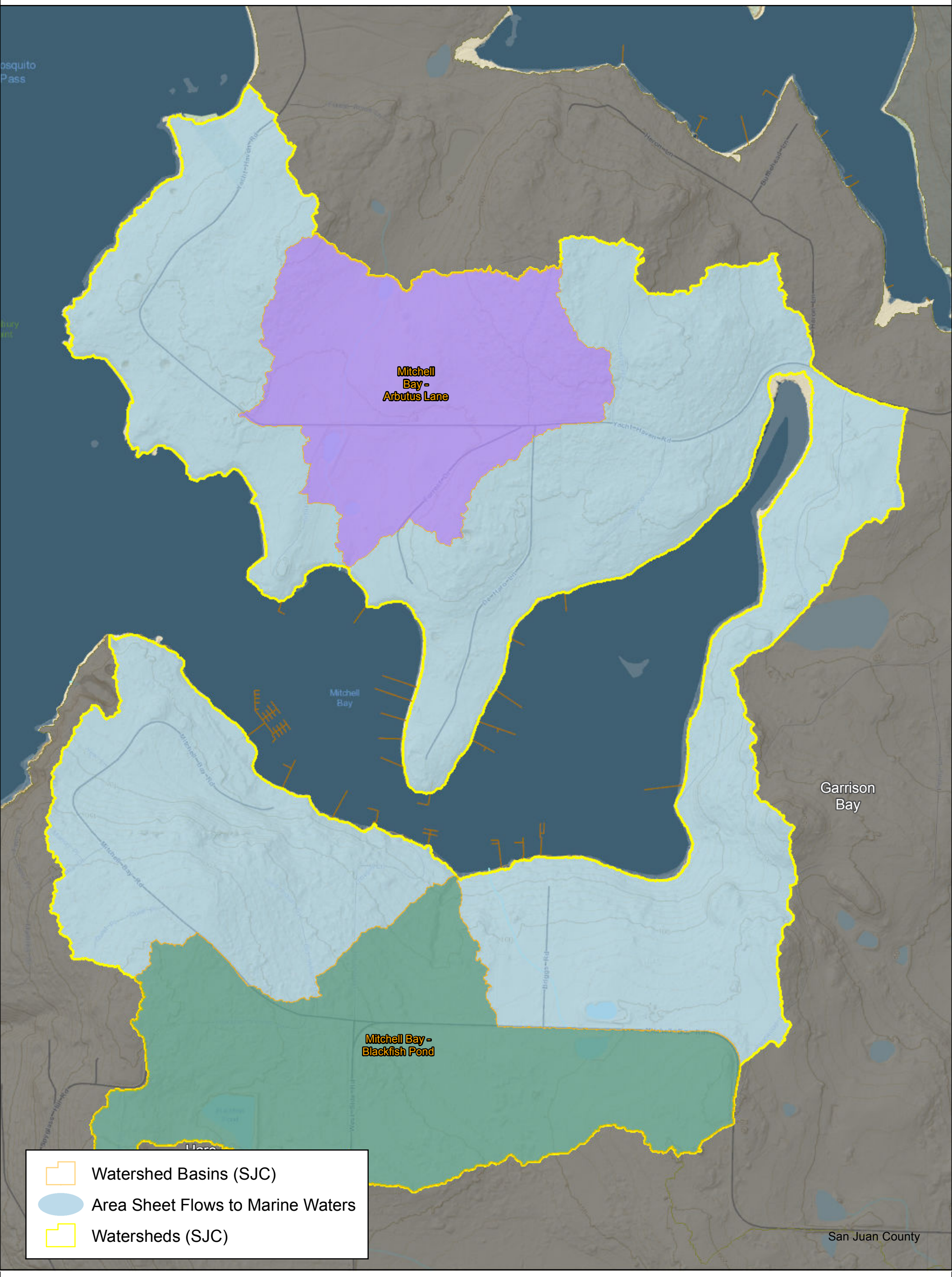
Juan de Fuca Strait Watershed Basin 1
False Bay Drive

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:00 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 780 Feet

Figure 31:
Overview of Mitchell Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:30 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

Figure 32:
Mitchell Bay Watershed Basin 1
Blackfish Pond

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:04 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 — 390 Feet

Figure 33:
Mitchell Bay Watershed Basin 2
Arbutus Lane

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:07 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

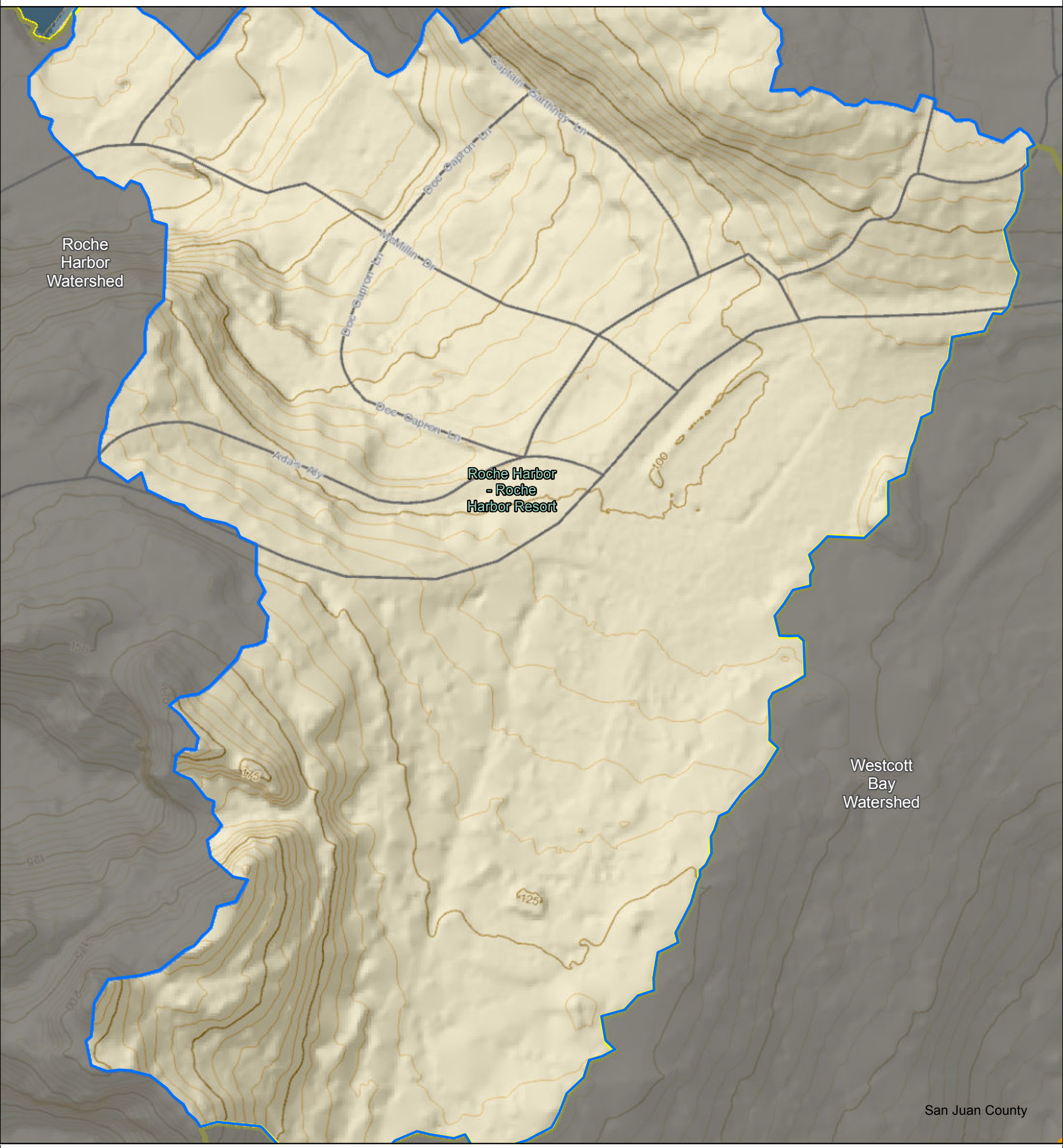
Figure 34:
Overview of Roche Harbor Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:34 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 100 feet

0 130 Feet

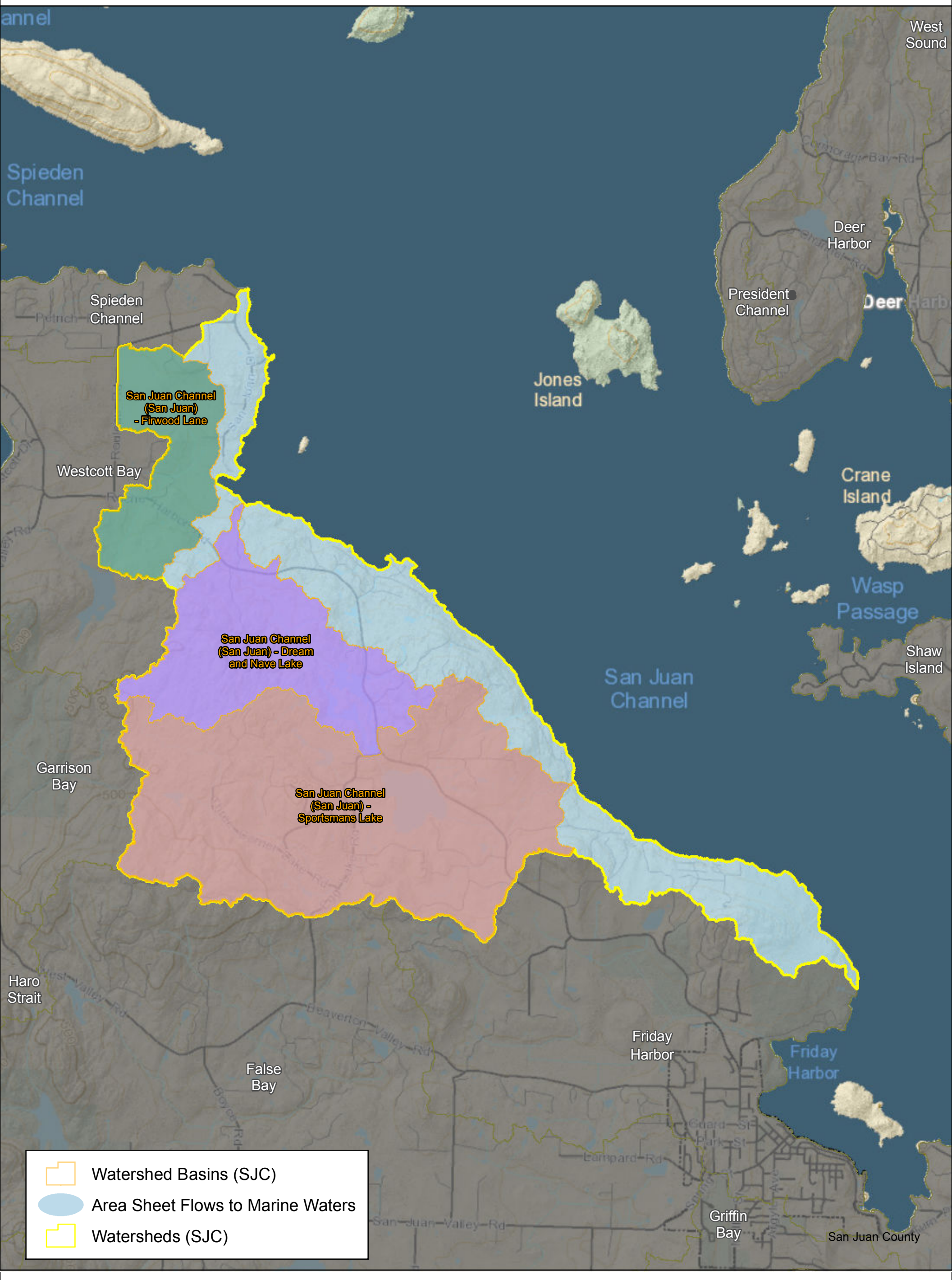
Figure 35:
Roche Harbor Watershed Basin 1
Roche Harbor Resort

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:13 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 3,200 feet

Feet
0 1,200 2,400 3,600

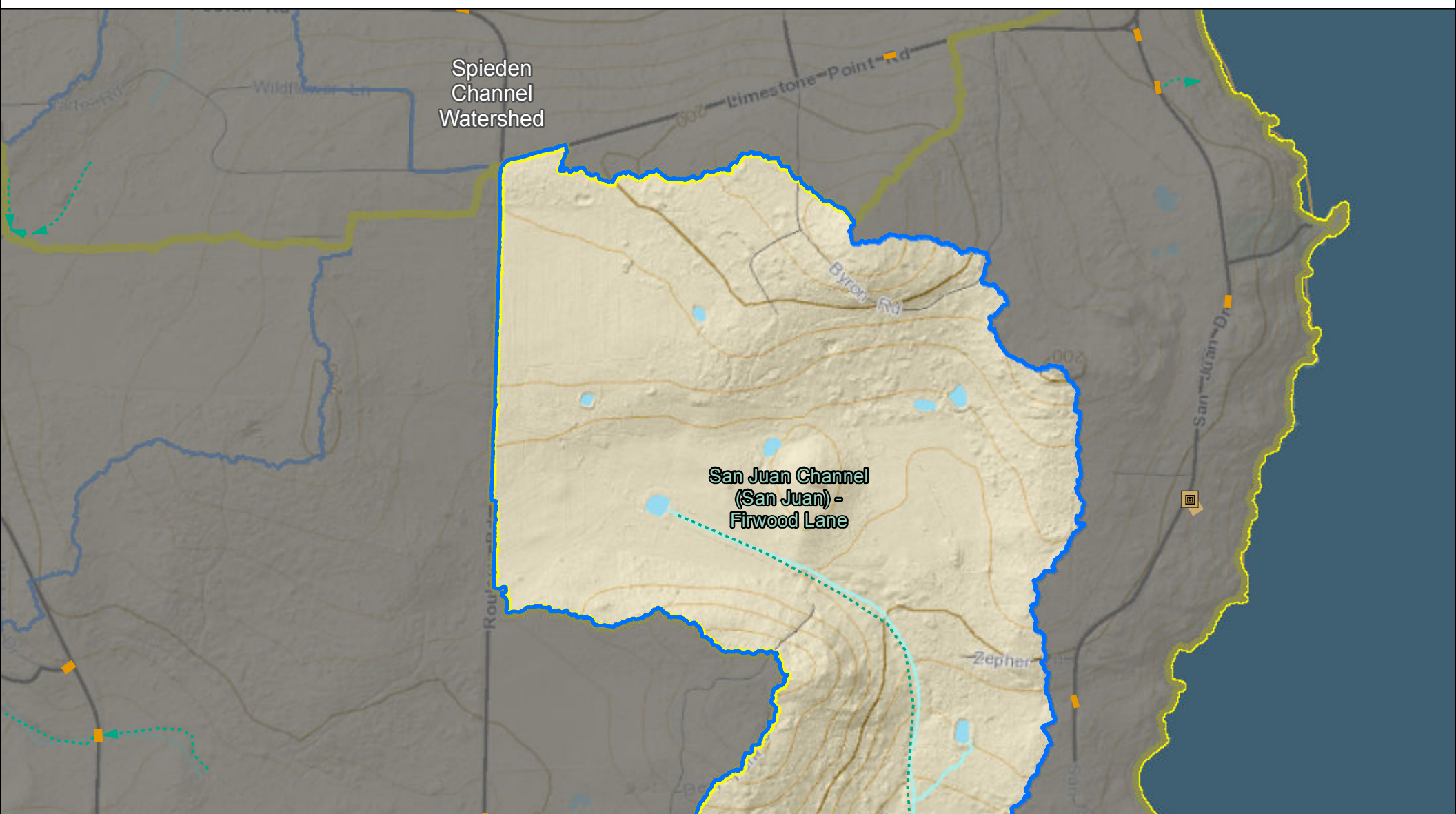
Figure 36:
Overview of San Juan Channel (San Juan) Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:37 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 900 feet

0 Feet 1,100

Figure 37:

San Juan Channel (San Juan) Watershed Basin

1

Firwood Lane

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:18 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,400 feet

Feet
0 1,200

Figure 38:
San Juan Channel (San Juan) Watershed Basin 2
Dream and Nave Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd
Drawn By: Nick Peihl
Date: 6/3/2014
Time: 11:07:23 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,900 feet

0 1,200 2,400 Feet

Figure 39:

San Juan Channel (San Juan) Watershed Basin 3

Sportsmans Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:28 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,400 feet

0 1,200 Feet

Figure 40:
Overview of Spieden Channel Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:41 AM



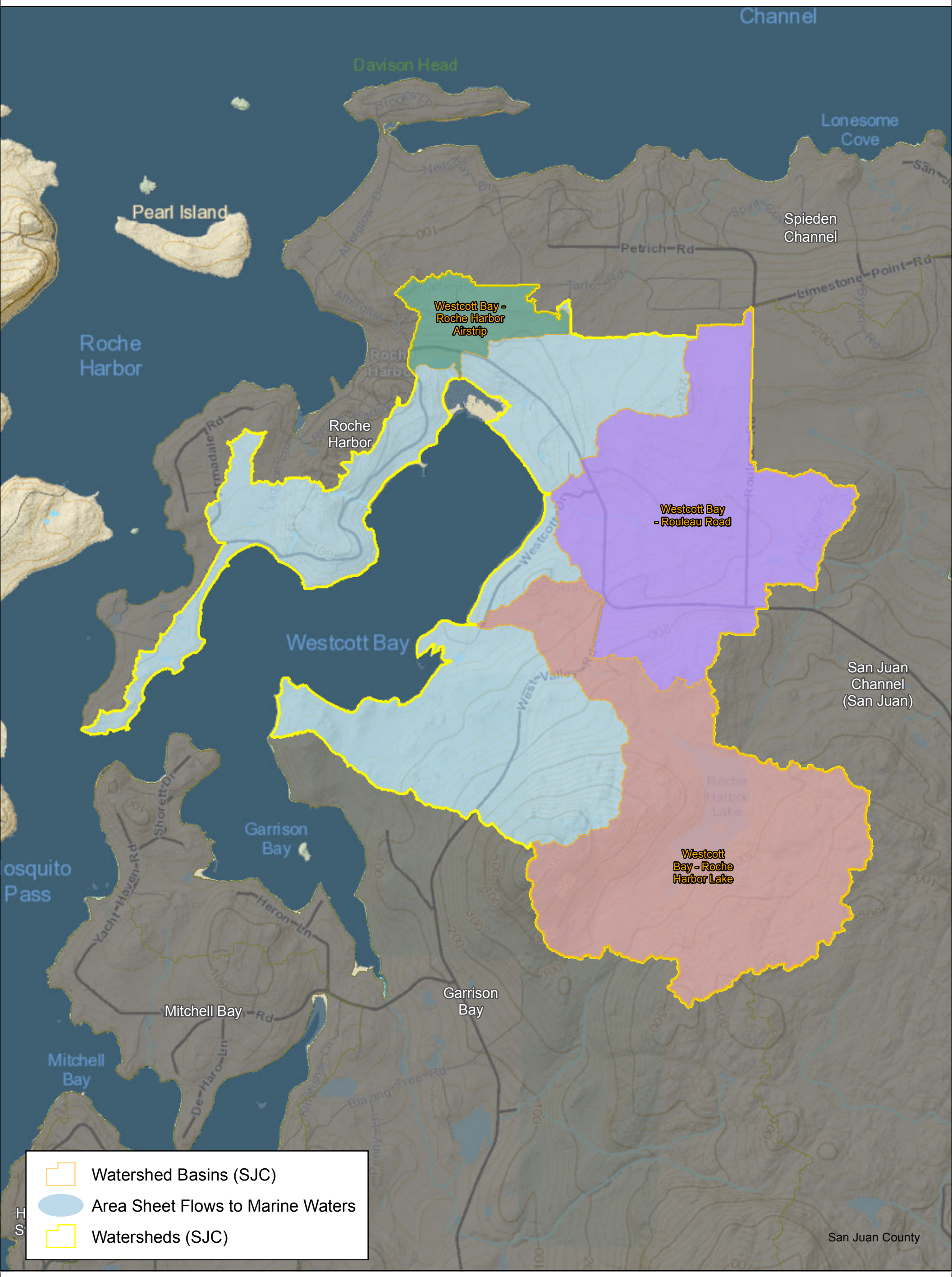
This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 400 feet

0 520 Feet

Figure 41:
Spieden Channel Watershed Basin 1
Petrich Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd Drawn By: Nick Peihl Date: 6/3/2014 Time: 11:07:33 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,600 feet

Feet
0 1,200

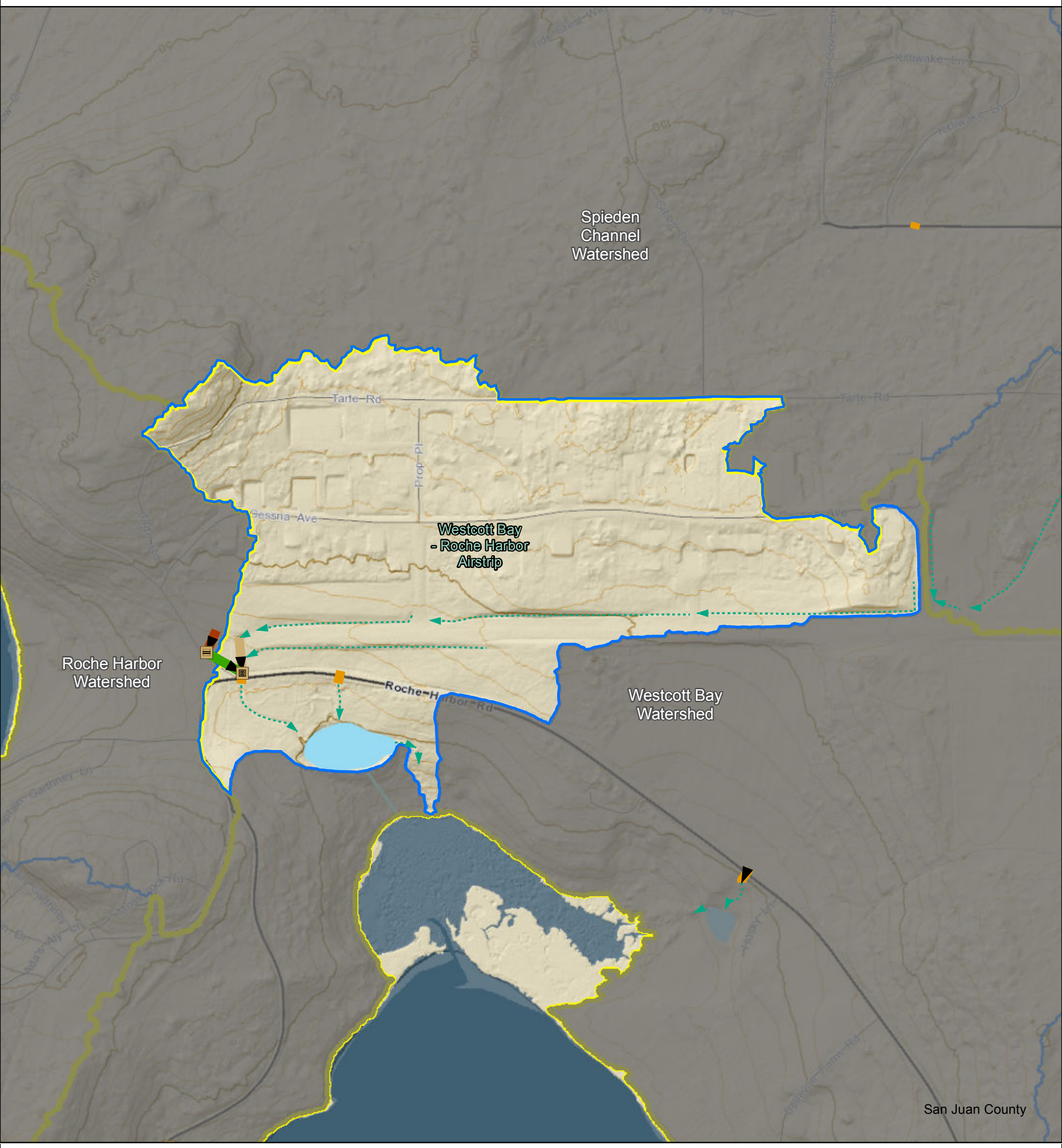
Figure 42:
Overview of Westcott Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:45 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 400 feet

0 520 Feet

Figure 43:

Westcott Bay Watershed Basin 1
Roche Harbor Airstrip

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:37 AM

Spieden Channel Watershed

Westcott Bay Watershed

San Juan Channel (San Juan) Watershed

Westcott Bay - Rouleau Road

San Juan County

Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

Cross Culvert
Ditchline Culvert
French Drain
Other
Storm Lateral
Storm Main

Structure Type

Checkdam
Drop Structure
Other
Standard Inlet
Type 1 Catch Basin
Type 1L Catch Basin
Type 2 Catch Basin
Unknown
Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 1,000 Feet

Figure 44:
Westcott Bay Watershed Basin 2
Rouleau Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:41 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 900 feet

0 Feet 1,100

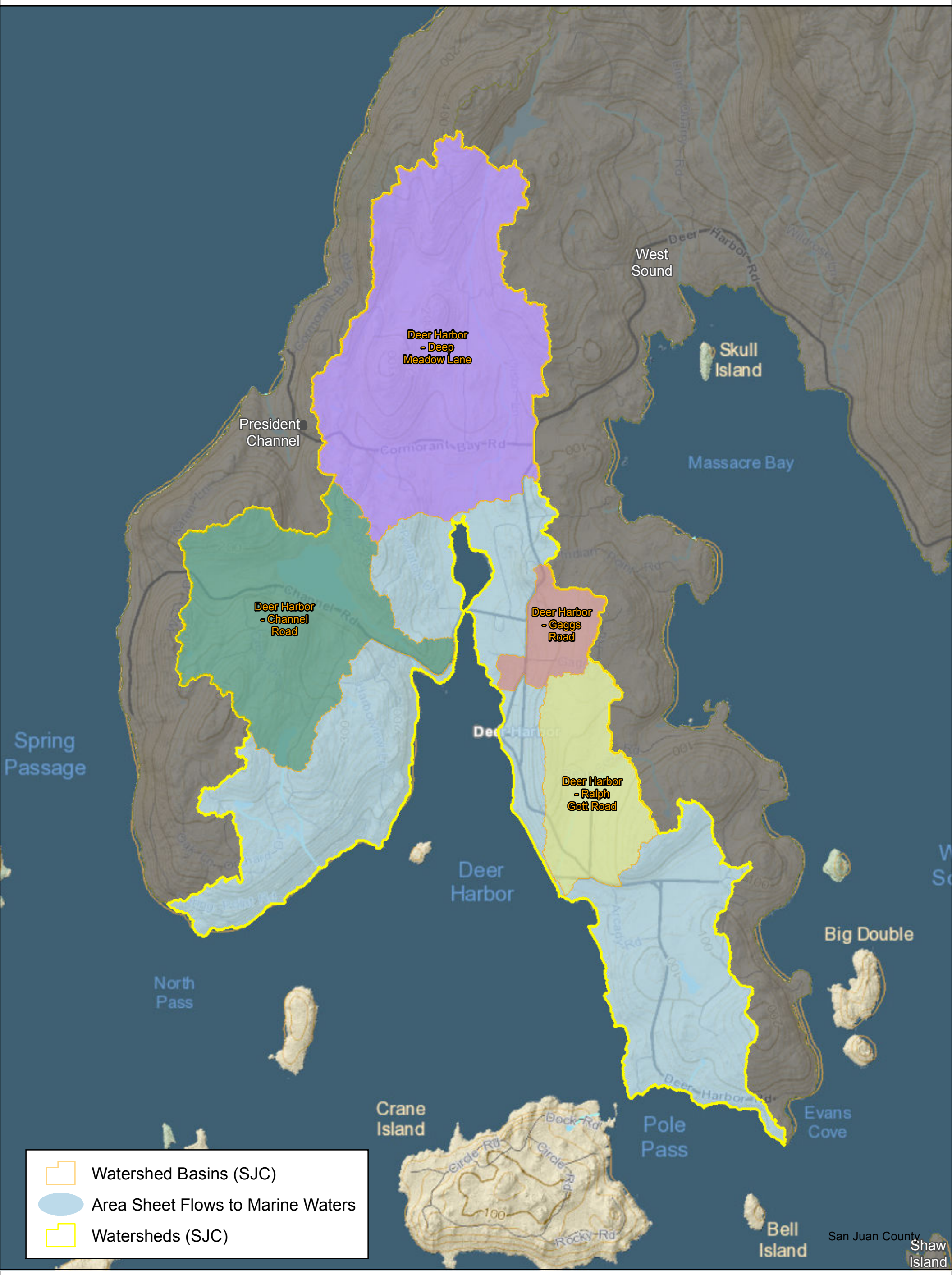
Figure 45:
Westcott Bay Watershed Basin 3
Roche Harbor Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:45 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,600 feet

Feet
0 1,200

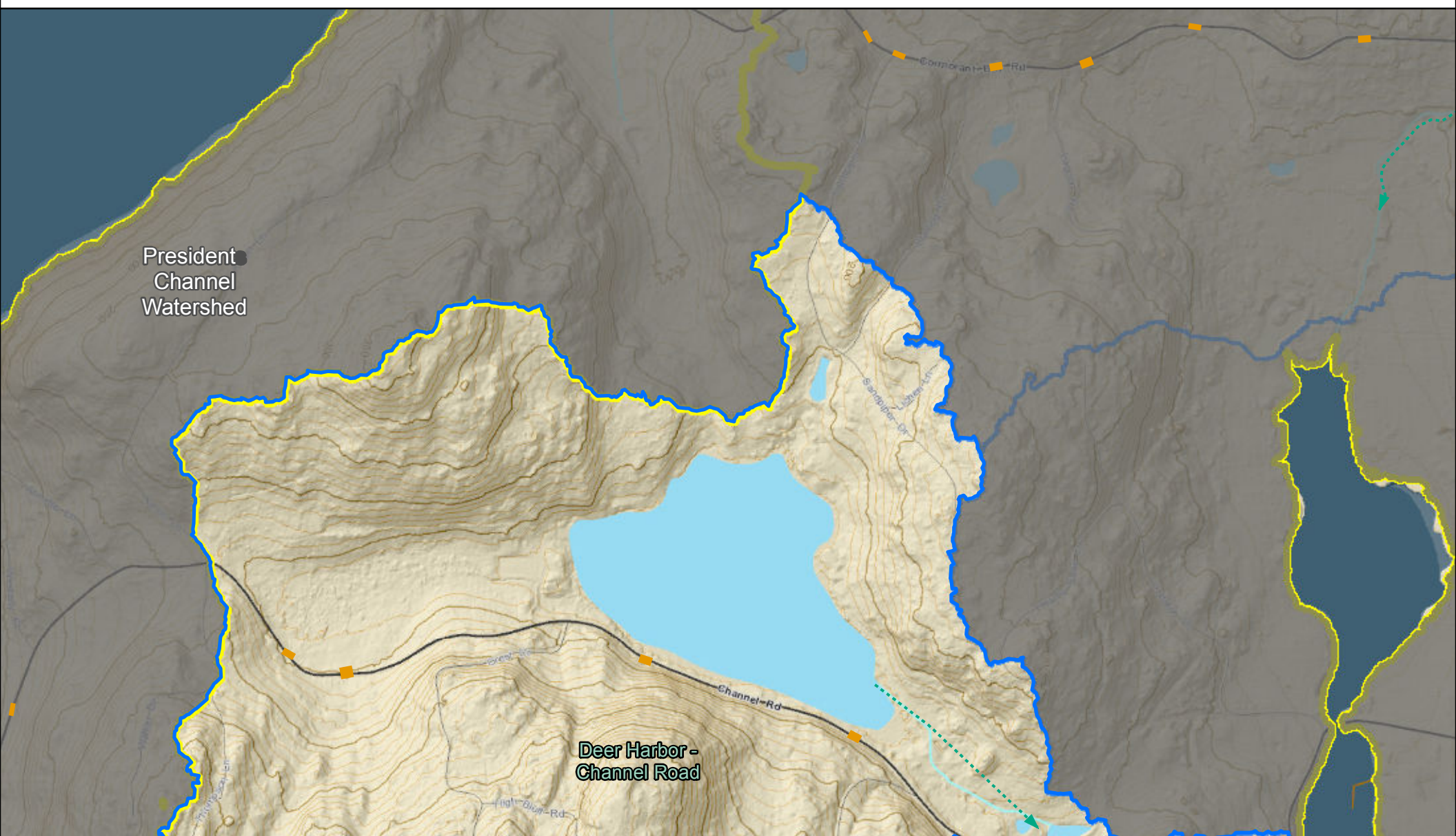
Figure 46:
Overview of Deer Harbor Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:48 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 — 780 Feet

Figure 47:
Deer Harbor Watershed Basin 1
Channel Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:52 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

Figure 48:
Deer Harbor Watershed Basin 2
Deep Meadow Lane

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:07:56 AM

West Sound Watershed

Deer Harbor Watershed

Deer Harbor - Gaggs Road

San Juan County

Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 390 Feet

Figure 49:
Deer Harbor Watershed Basin 3
Gaggs Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:00 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

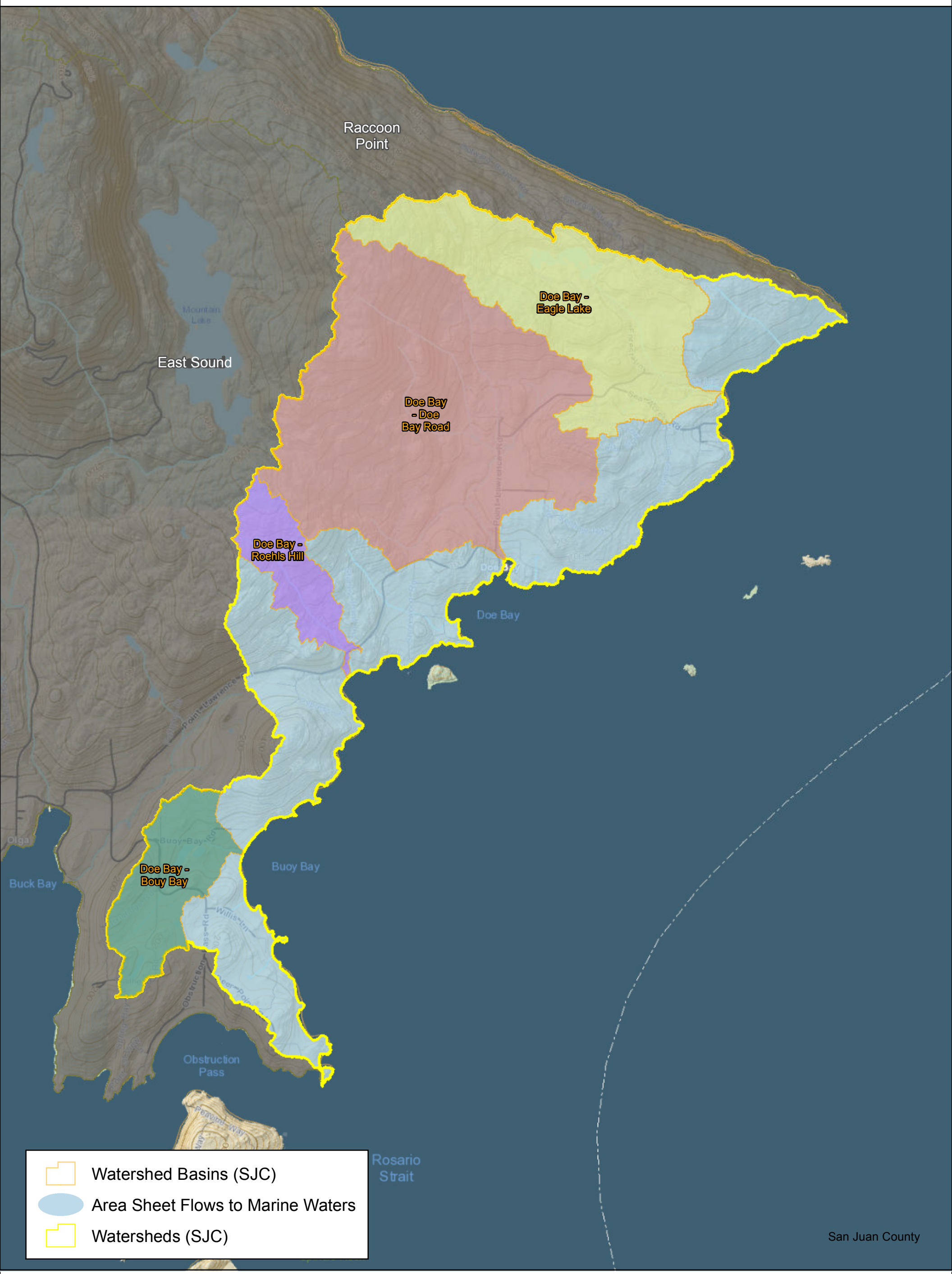
Figure 50:
Deer Harbor Watershed Basin 4
Ralph Gott Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:04 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,400 feet

Feet
0 1,200 2,400

Figure 51:
Overview of Doe Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:52 AM

East Sound Watershed

Doe Bay - Bouy Bay

Doe Bay Watershed

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 780 Feet

Figure 52:
Doe Bay Watershed Basin 1
Bouy Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:10 AM

East Sound Watershed

Doe Bay - Roehls Hill

Doe Bay Watershed

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 780 Feet

Figure 53:
Doe Bay Watershed Basin 2
Roehls Hill

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:16 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,100 feet

0 — 1,200 Feet

Figure 54:
Doe Bay Watershed Basin 3
Doe Bay Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:23 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,200 feet

0 — 1,200 Feet

Figure 55:
Doe Bay Watershed Basin 4
Eagle Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:27 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 4,600 feet

Feet
0 1,200 2,400 4,800

Figure 56:
Overview of East Sound Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:03:55 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

Figure 57:
East Sound Watershed Basin 1
Martin Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:34 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

Figure 58:
East Sound Watershed Basin 2
Ayer Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:38 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

SAN JUAN COUNTY WASHINGTON

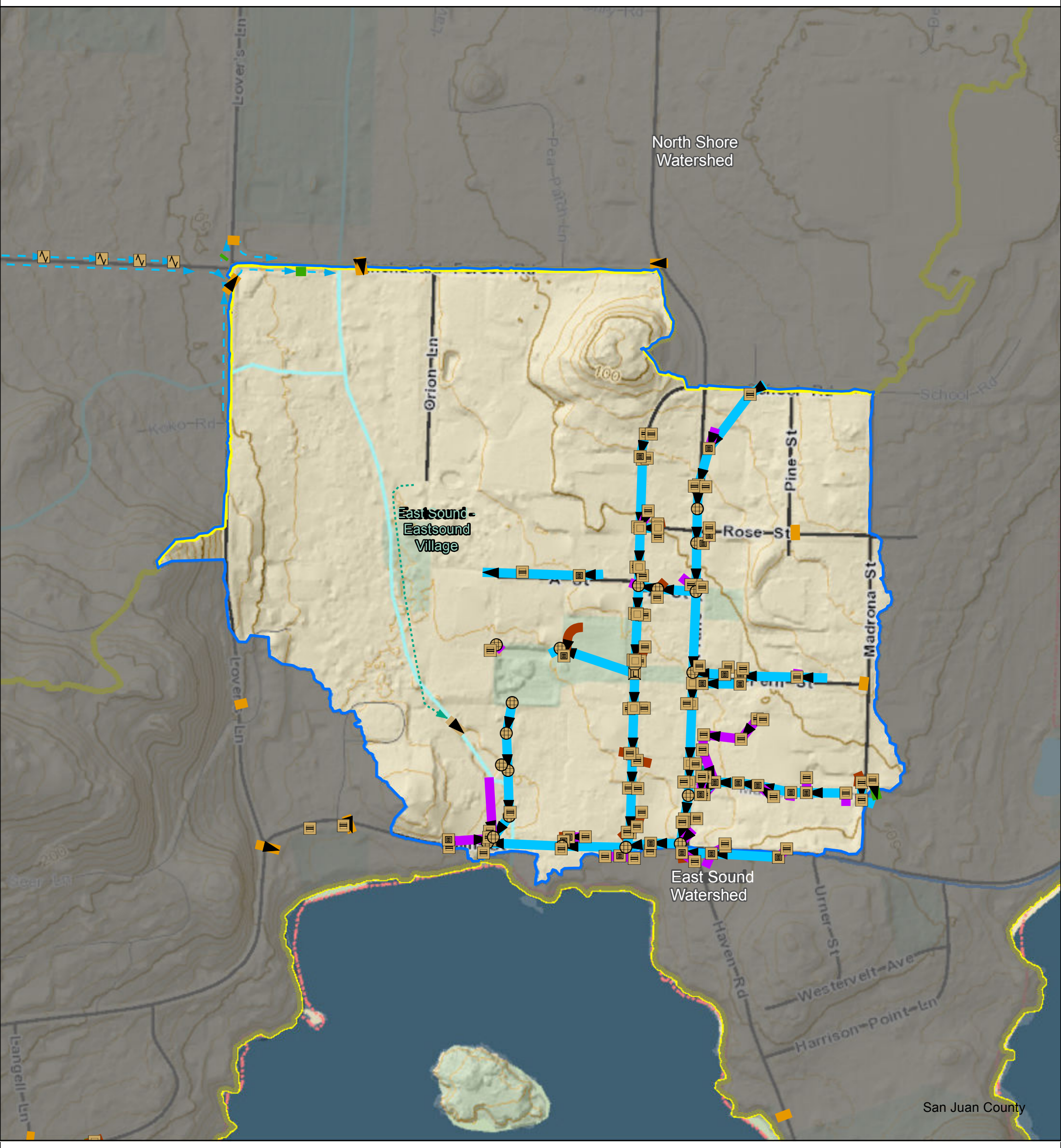
This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,200 feet

0 Feet 1,200

Figure 59:
East Sound Watershed Basin 3
Fowlers Pond

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd Drawn By: Nick Peihl Date: 6/3/2014 Time: 11:08:45 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 — 390 Feet

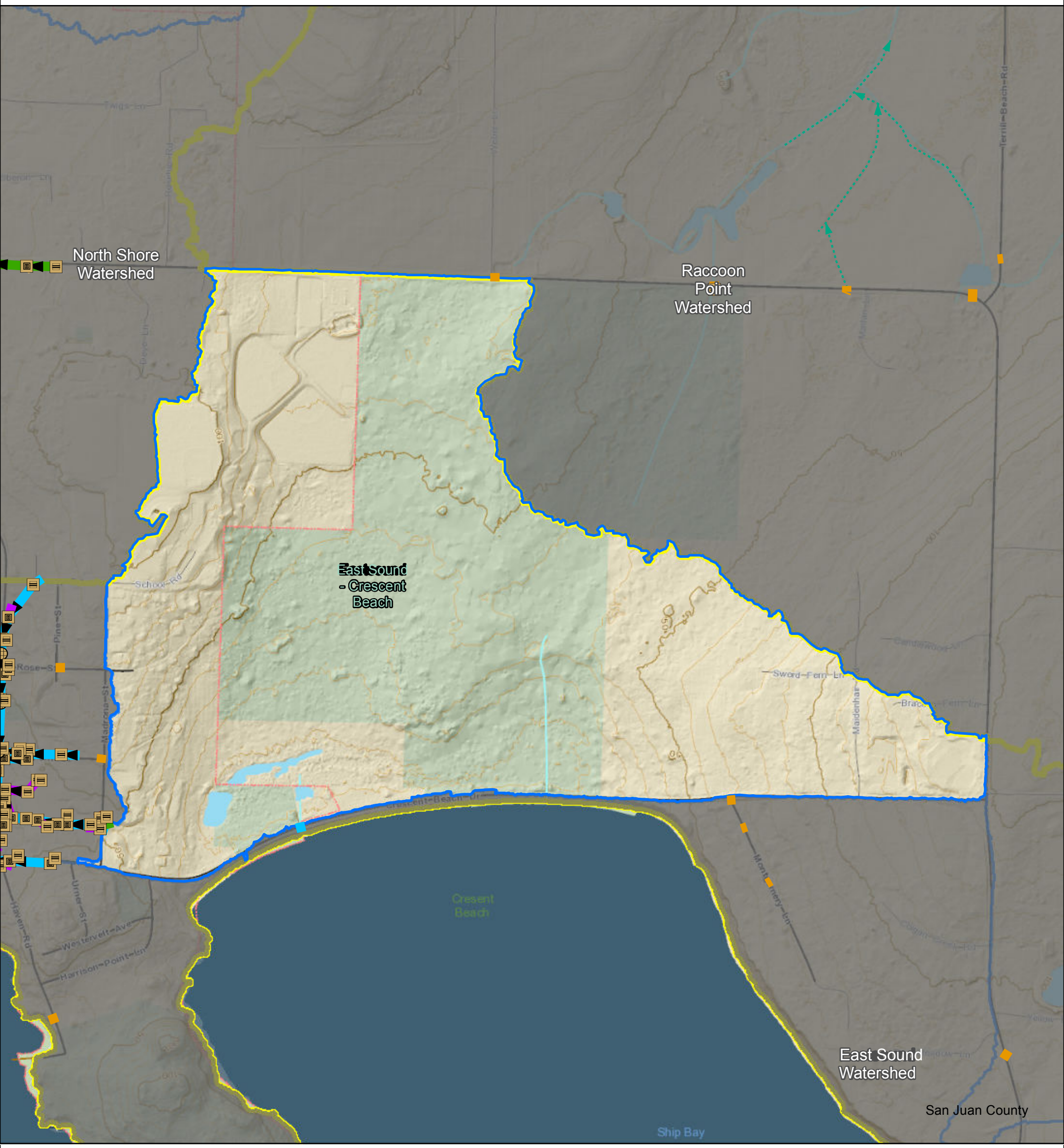
Figure 60:
East Sound Watershed Basin 4
Eastsound Village

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:51 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

Figure 61:
East Sound Watershed Basin 5
Crescent Beach

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:08:56 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 — Feet — 920

Figure 62:
East Sound Watershed Basin 6
Ship Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:01 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,300 feet

0 — 1,200 Feet

Figure 63:
East Sound Watershed Basin 7
Purdue Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:06 AM

East Sound
- Youngrens
Pond

East Sound
Watershed

San Juan County

Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

Cross Culvert
Ditchline Culvert
French Drain
Other
Storm Lateral
Storm Main

Structure Type

Checkdam
Drop Structure
Other
Standard Inlet

Type 1 Catch Basin
Type 1L Catch Basin
Type 2 Catch Basin
Unknown
Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

Figure 64:
East Sound Watershed Basin 8
Youngrens Pond



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,400 feet

Feet
0 1,200

Figure 65:
East Sound Watershed Basin 9
Cascade Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:16 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,200 feet

0 1,200 2,400 Feet

Figure 66:
East Sound Watershed Basin 10
Mountain Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:21 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,200 feet

0 — 1,200 Feet

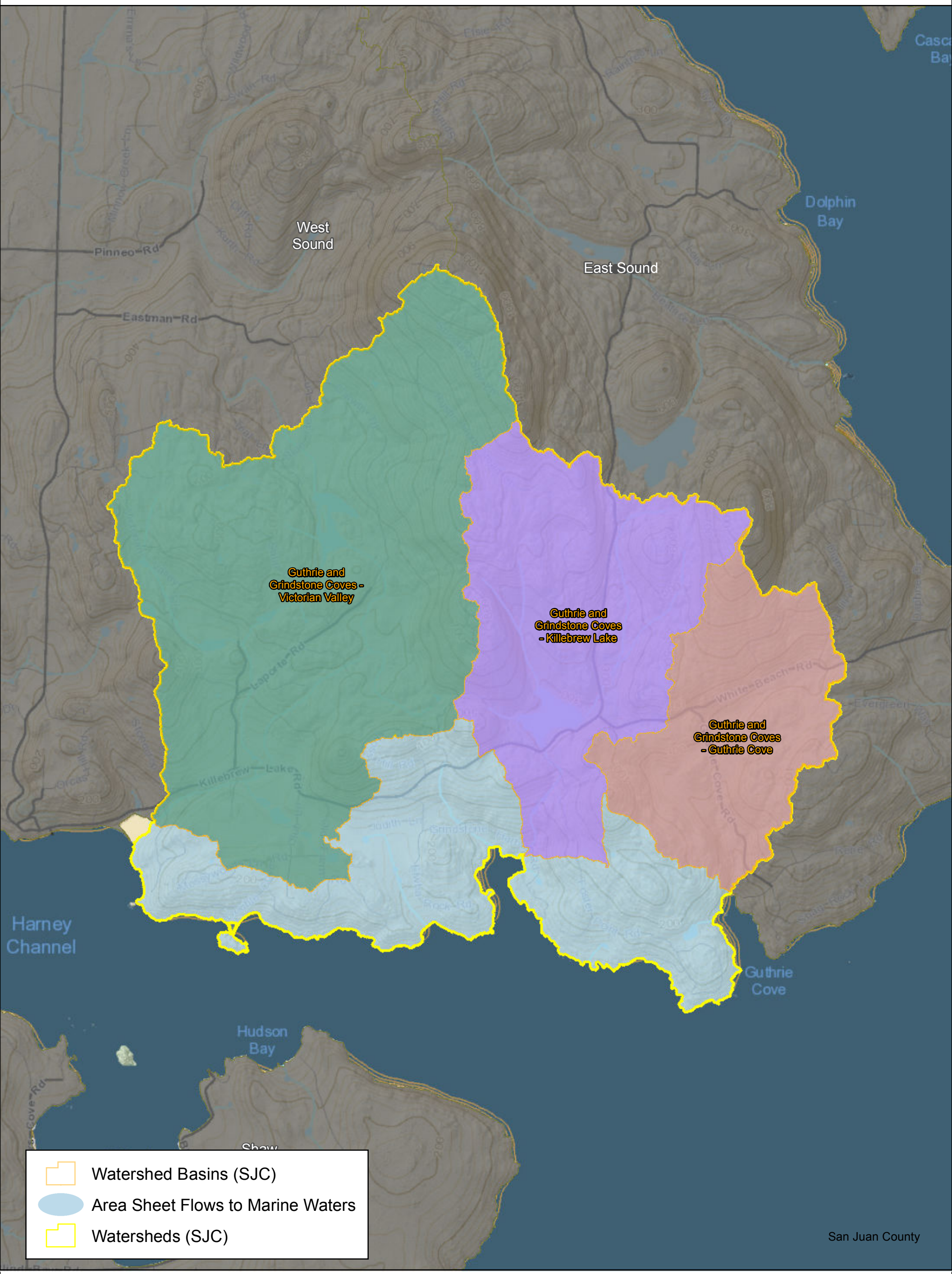
Figure 67:
East Sound Watershed Basin 11
Obstruction Pass Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:25 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,800 feet

Feet
0 1,200

Figure 68:
Overview of Guthrie and Grindstone Coves Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:00 AM

West Sound Watershed

East Sound Watershed

Guthrie and Grindstone Coves - Victorian Valley

Guthrie and Grindstone Coves Watershed

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,400 feet

0 — 1,200 Feet

Figure 69:

Guthrie and Grindstone Coves Watershed
Basin 1
Victorian Valley

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:31 AM

East Sound Watershed

Guthrie and Grindstone Coves - Killebrew Lake

Guthrie and Grindstone Coves Watershed

San Juan County

Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,000 feet

0 Feet 1,200

Figure 70:
Guthrie and Grindstone Coves Watershed
Basin 2
Killebrew Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:37 AM

Guthrie and Grindstone Coves Watershed

Guthrie and Grindstone Coves - Guthrie Cove

East Sound Watershed

Killebrew Lake

Hurricane Hill Rd

White Beach Rd

Guthrie Cove Rd

Diamond Hill Rd

Evergreen Way

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 1,000 Feet

Figure 71:

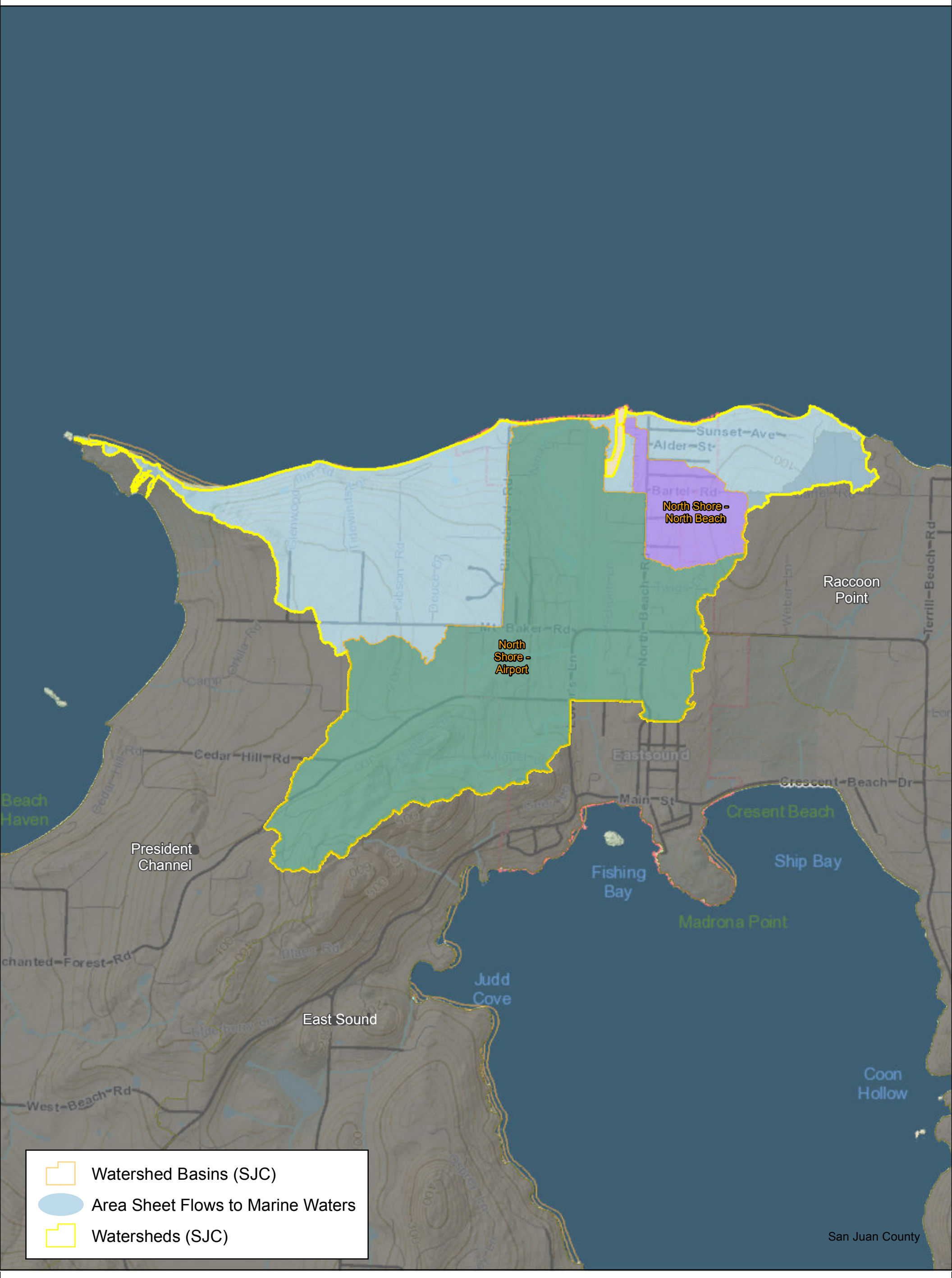
Guthrie and Grindstone Coves Watershed
Basin 3
Guthrie Cove

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:41 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,600 feet

Feet
0 1,200

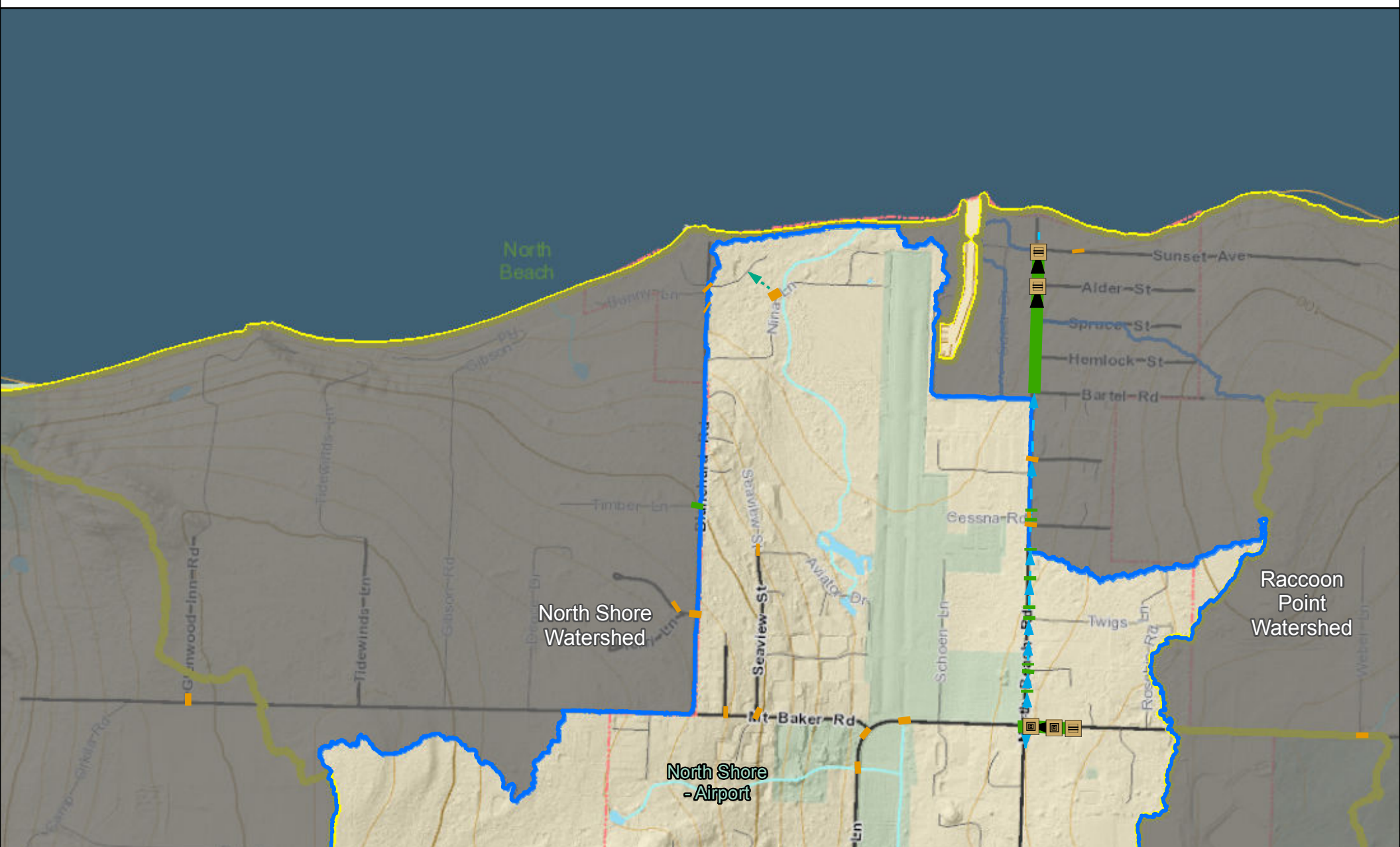
Figure 72:
Overview of North Shore Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:03 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,000 feet

0 — 1,200 Feet

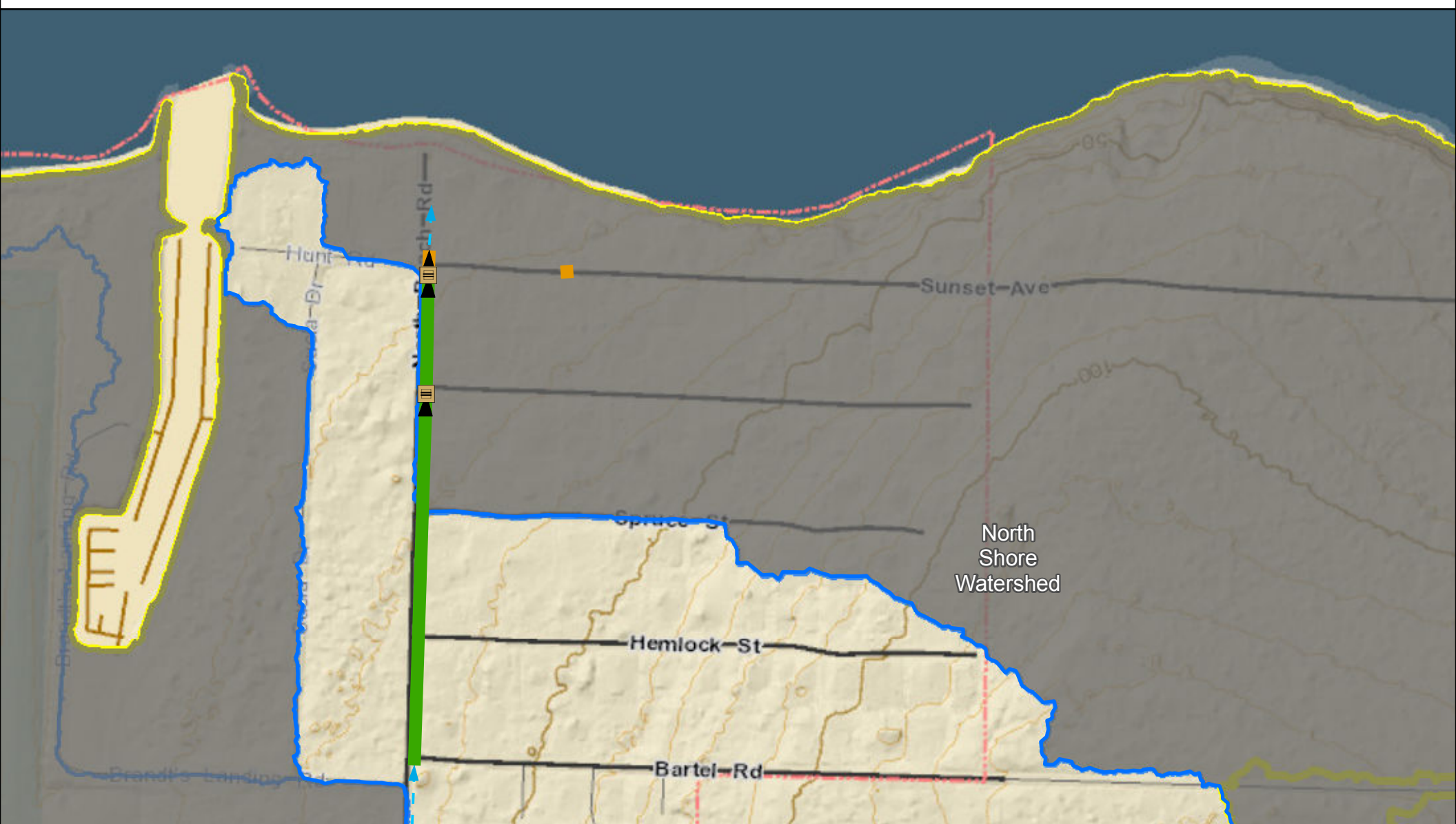
Figure 73:
North Shore Watershed Basin 1 Airport

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:48 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 — 390 Feet

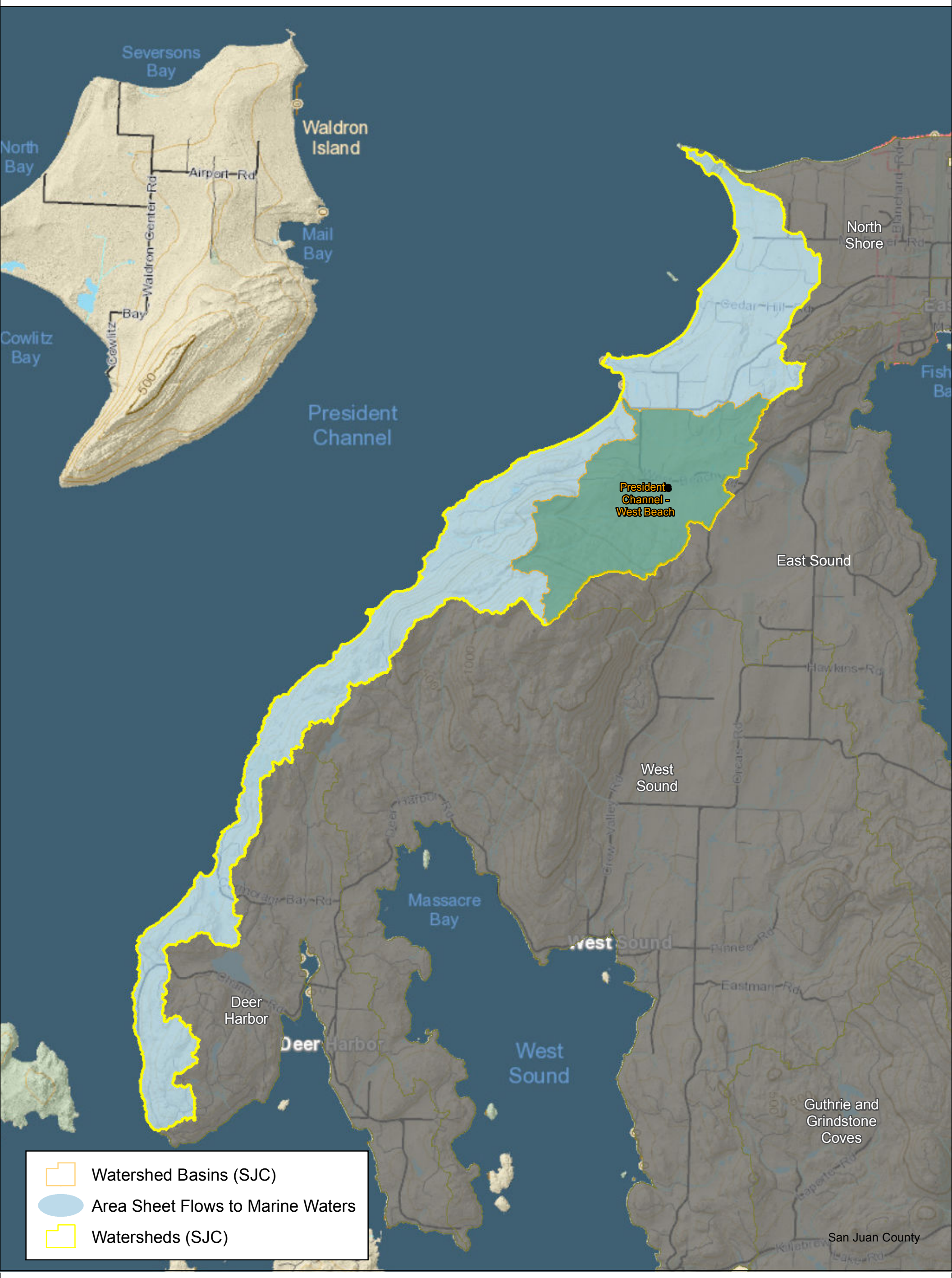
Figure 74:
North Shore Watershed Basin 2
North Beach

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:52 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 3,200 feet

Feet
0 1,200 2,400 3,600

Figure 75:
Overview of President Channel Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:06 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,100 feet

0 — 1,200 Feet

Figure 76:

President Channel Watershed Basin 1
West Beach

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:09:58 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 4,400 feet

Feet
0 1,200 2,400 3,600

Figure 77:
Overview of Raccoon Point Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:09 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

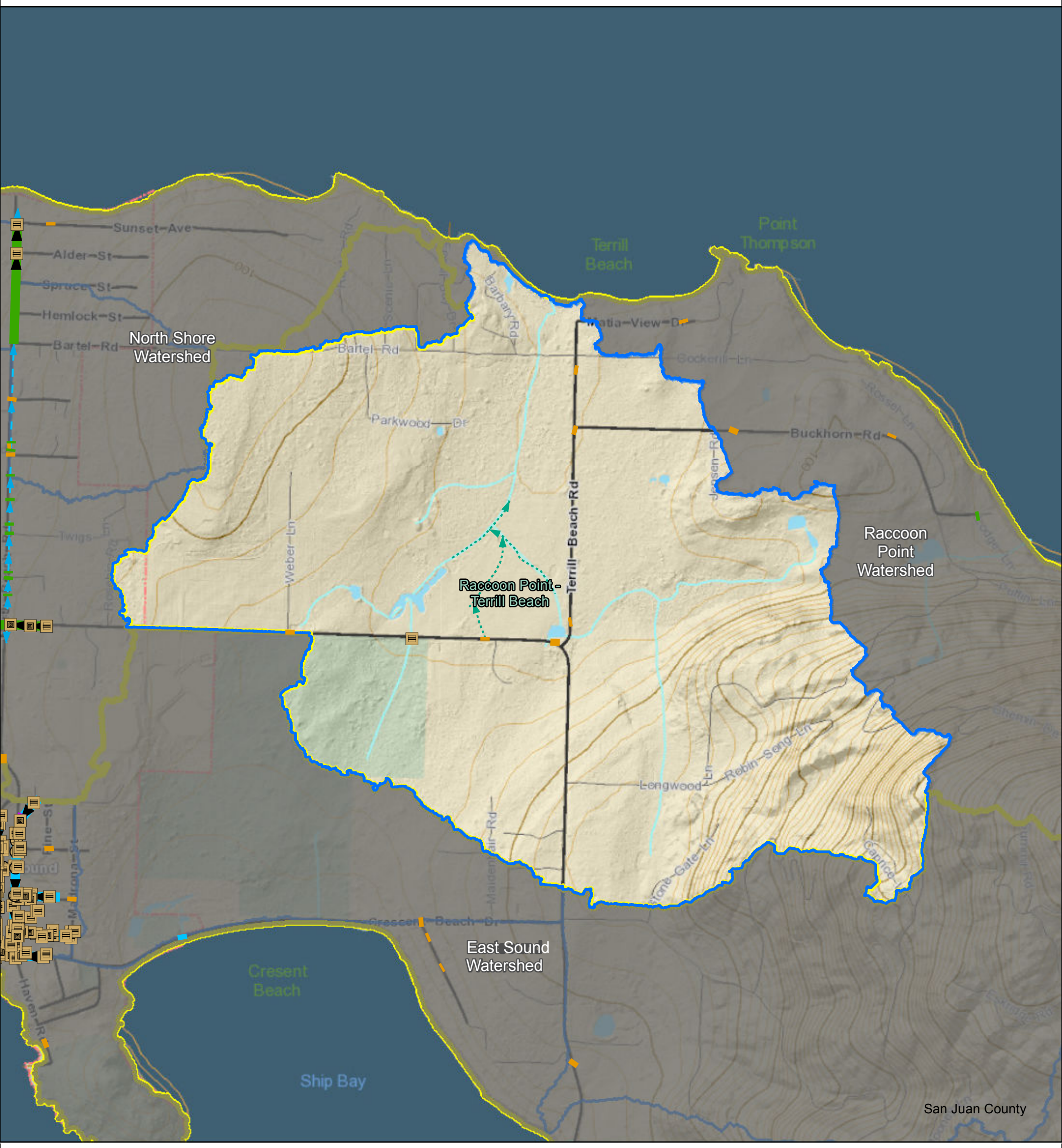
Figure 78:
Raccoon Point Watershed Basin 1
Day Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:04 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 900 feet

0 — 1,100 Feet

Figure 79:

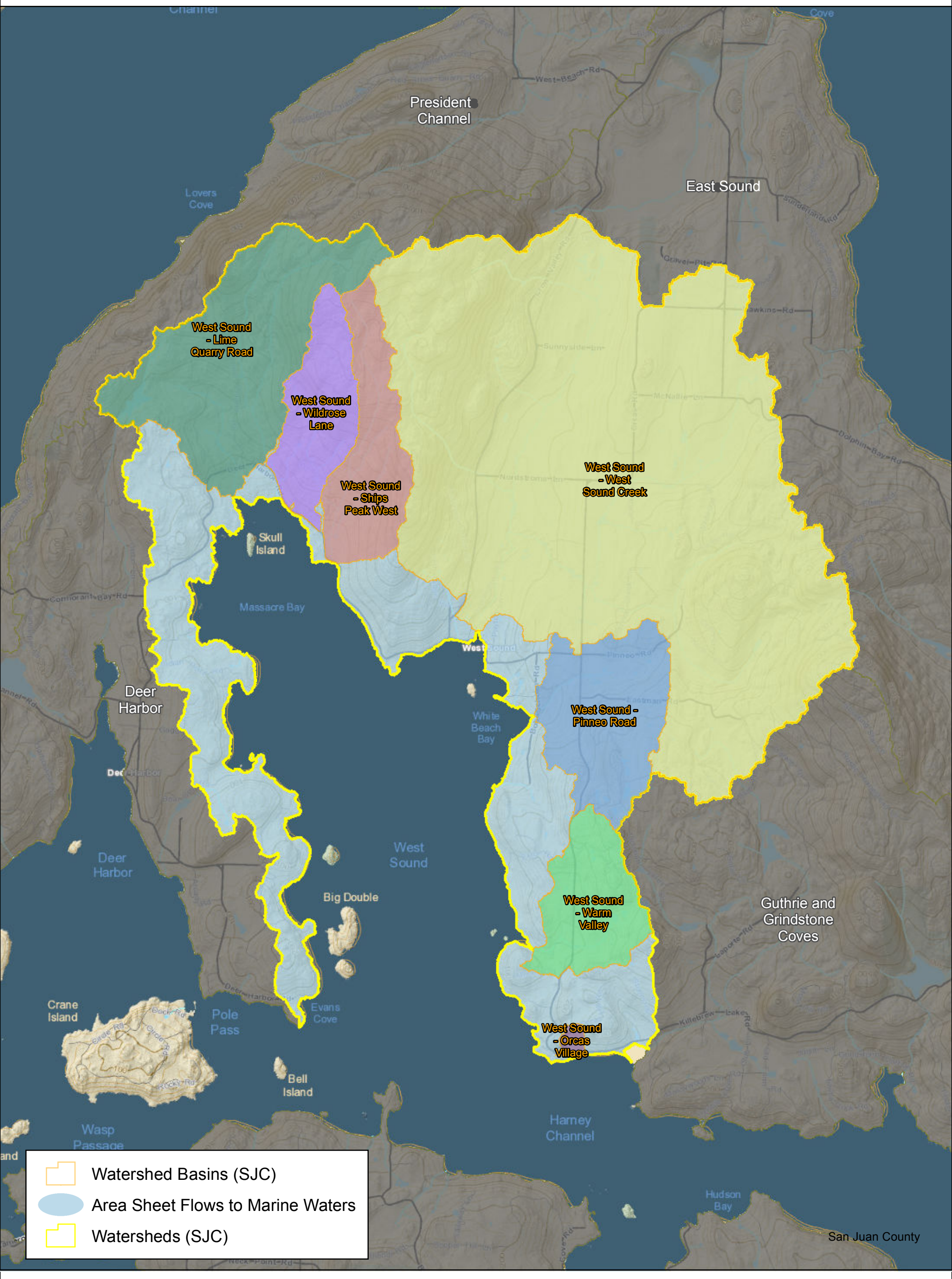
Raccoon Point Watershed Basin 2
Terrill Beach

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:08 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,600 feet

Feet
0 1,200 2,400

Figure 80:
Overview of West Sound Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:13 AM

Lovers Cove

President Channel Watershed

East Sound Watershed

West Sound - Lime Quarry Road

West Sound Watershed

Deer Harbor Watershed

Skull Island

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,000 feet

0 — 1,200 Feet

Figure 81:

West Sound Watershed Basin 1
Lime Quarry Road

President Channel Watershed

West Sound Watershed

West Sound - Wildrose Lane

Skull Island

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 Feet 1,000

Figure 82:
West Sound Watershed Basin 2
Wildrose Lane

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:19 AM

President Channel Watershed

East Sound Watershed

West Sound Watershed

West Sound - Ships Peak West

Skull Island

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 900 feet

0 — 1,100 Feet

Figure 83:

West Sound Watershed Basin 3
Ships Peak West

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:23 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,900 feet

0 1,200 2,400 Feet

Figure 84:

West Sound Watershed Basin 4
West Sound Creek

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:29 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 920 Feet

Figure 85:

West Sound Watershed Basin 5
Pinneo Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:35 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 — 780 Feet

Figure 86:
West Sound Watershed Basin 6
Warm Valley

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:41 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 100 feet

0 130 Feet

Figure 87:

West Sound Watershed Basin 7
Orcas Village

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:47 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 1,000 Feet

Figure 88:
Overview of Aleck Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:16 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

SAN JUAN COUNTY WASHINGTON

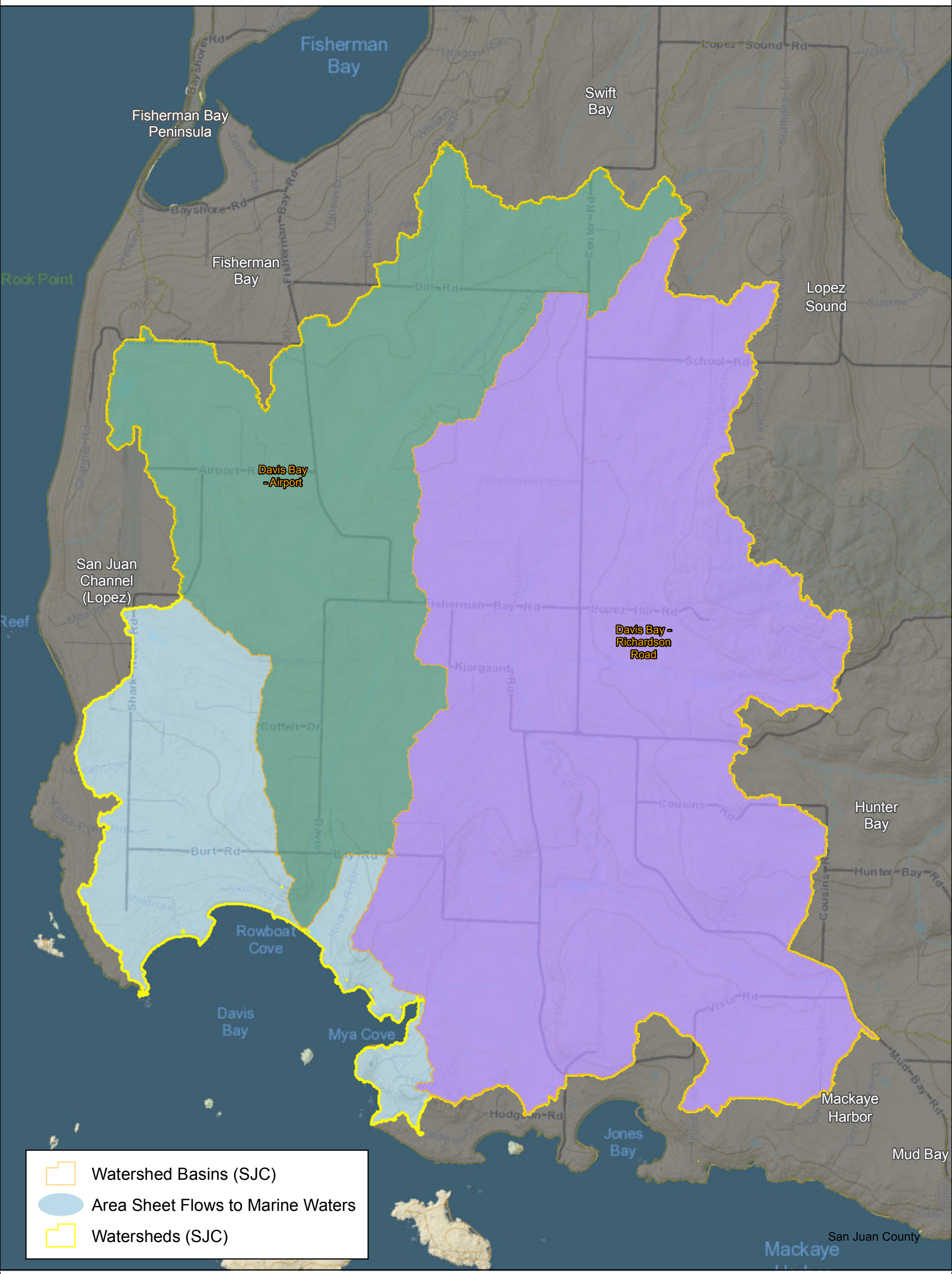
This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 390 Feet

Figure 89:

Aleck Bay Watershed Basin 1
Hutton Lane



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,800 feet

Feet
0 1,200

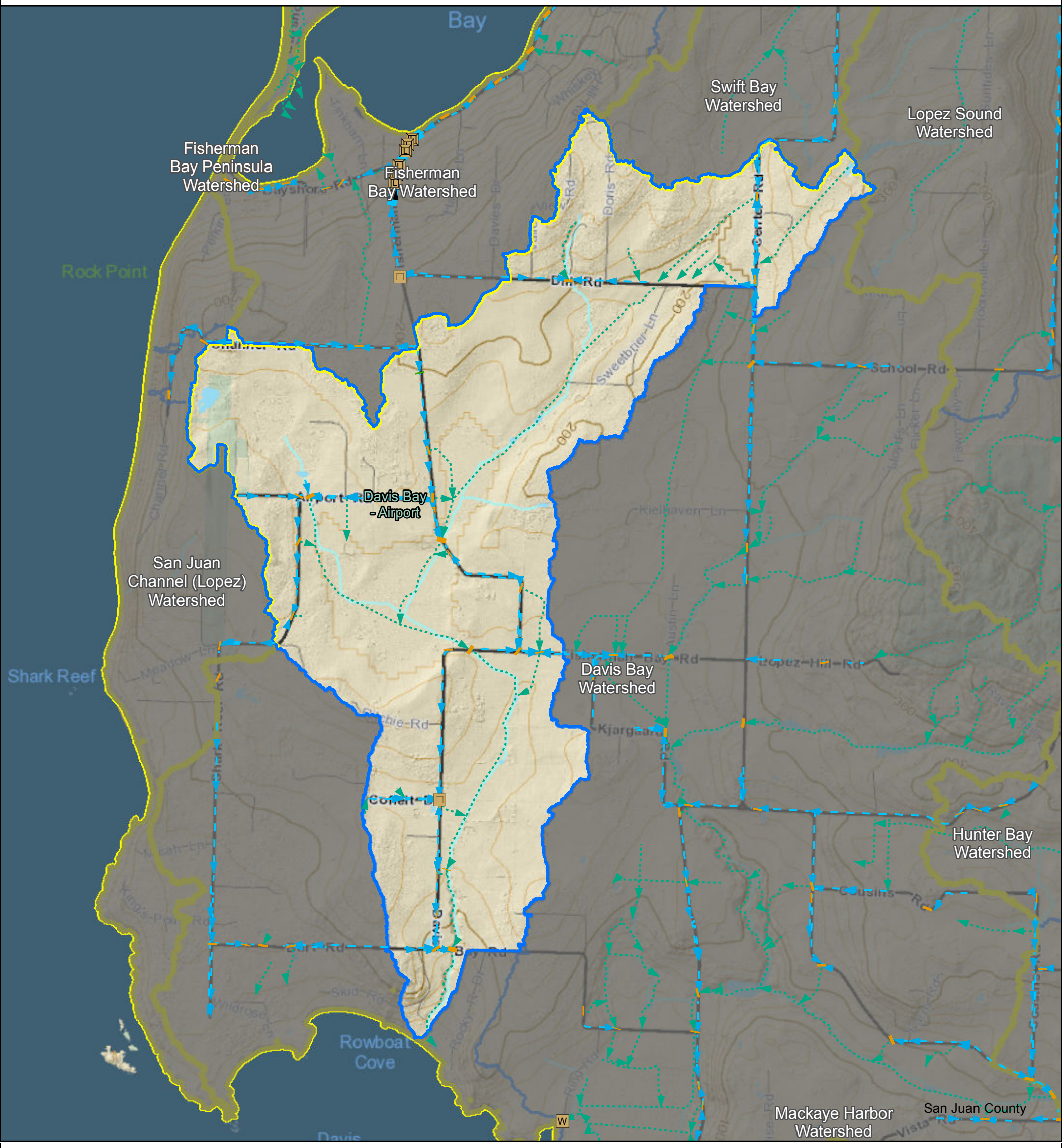
Figure 90:
Overview of Davis Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:20 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,700 feet

Feet
0 1,200

Figure 91:
Davis Bay Watershed Basin 1 Airport

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:10:58 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,000 feet

Feet
0 1,200 2,400

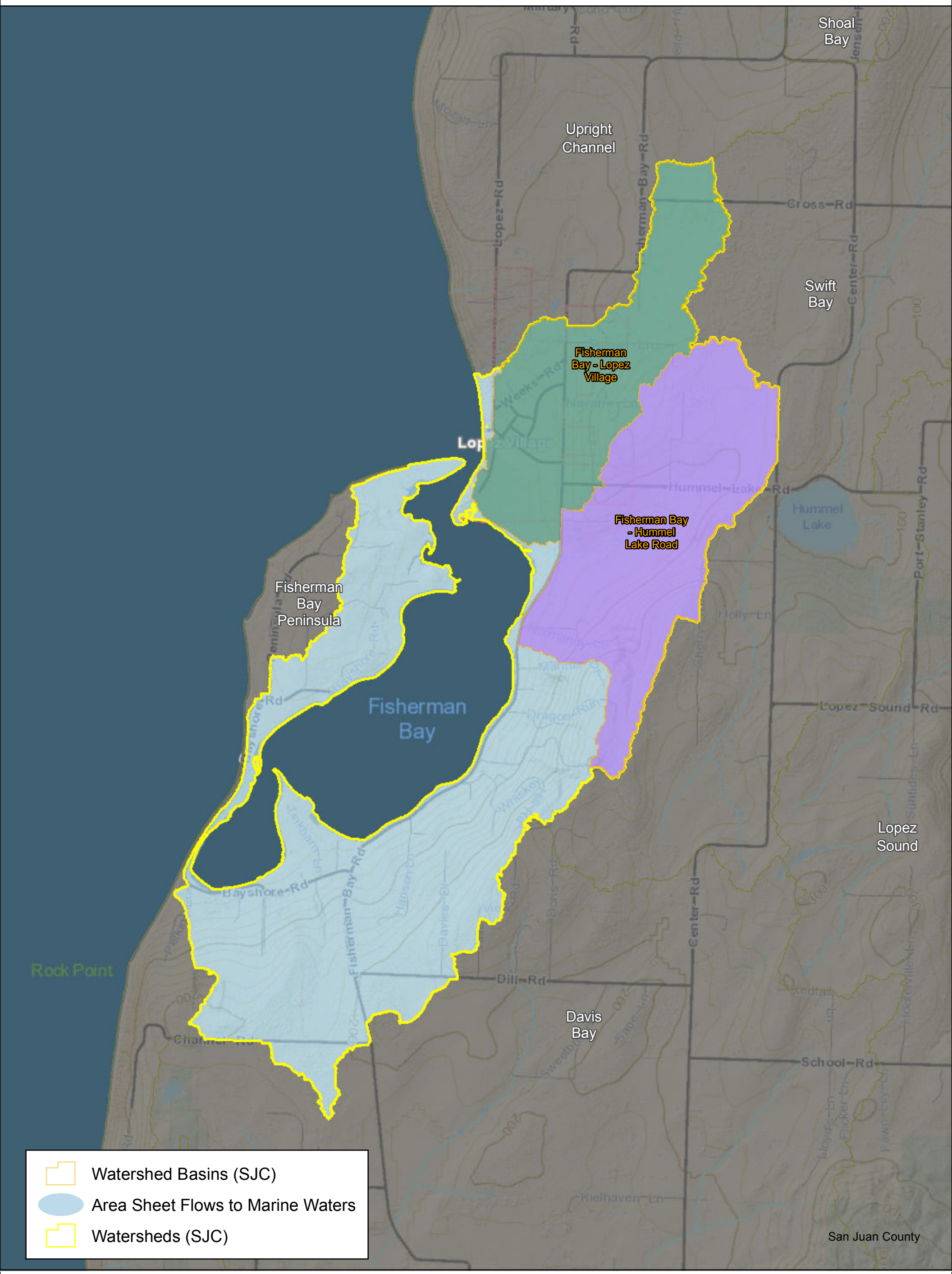
Figure 92:
Davis Bay Watershed Basin 2
Richardson Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:03 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,600 feet

Feet
0 1,200

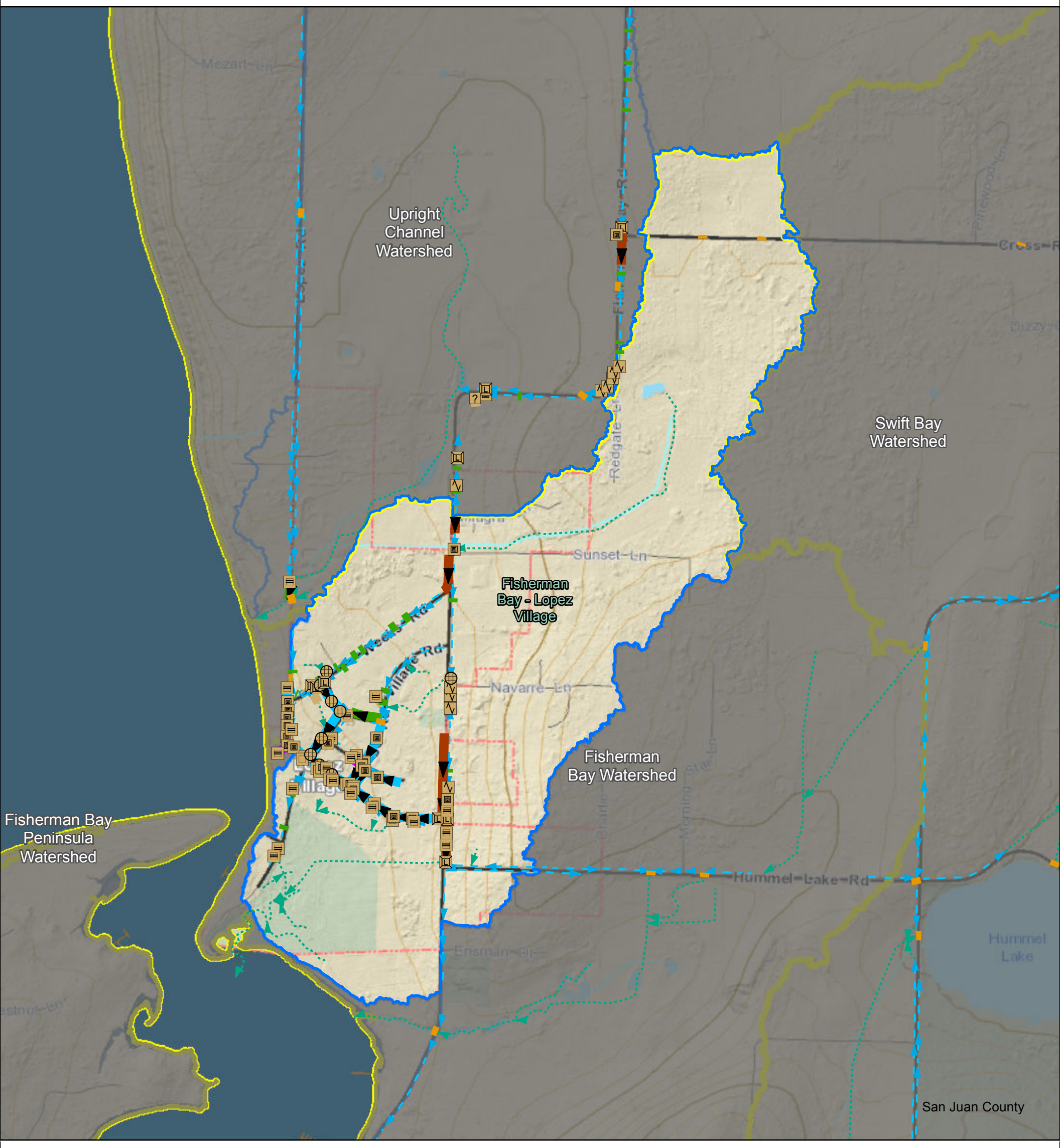
Figure 93:
Overview of Fisherman Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:23 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

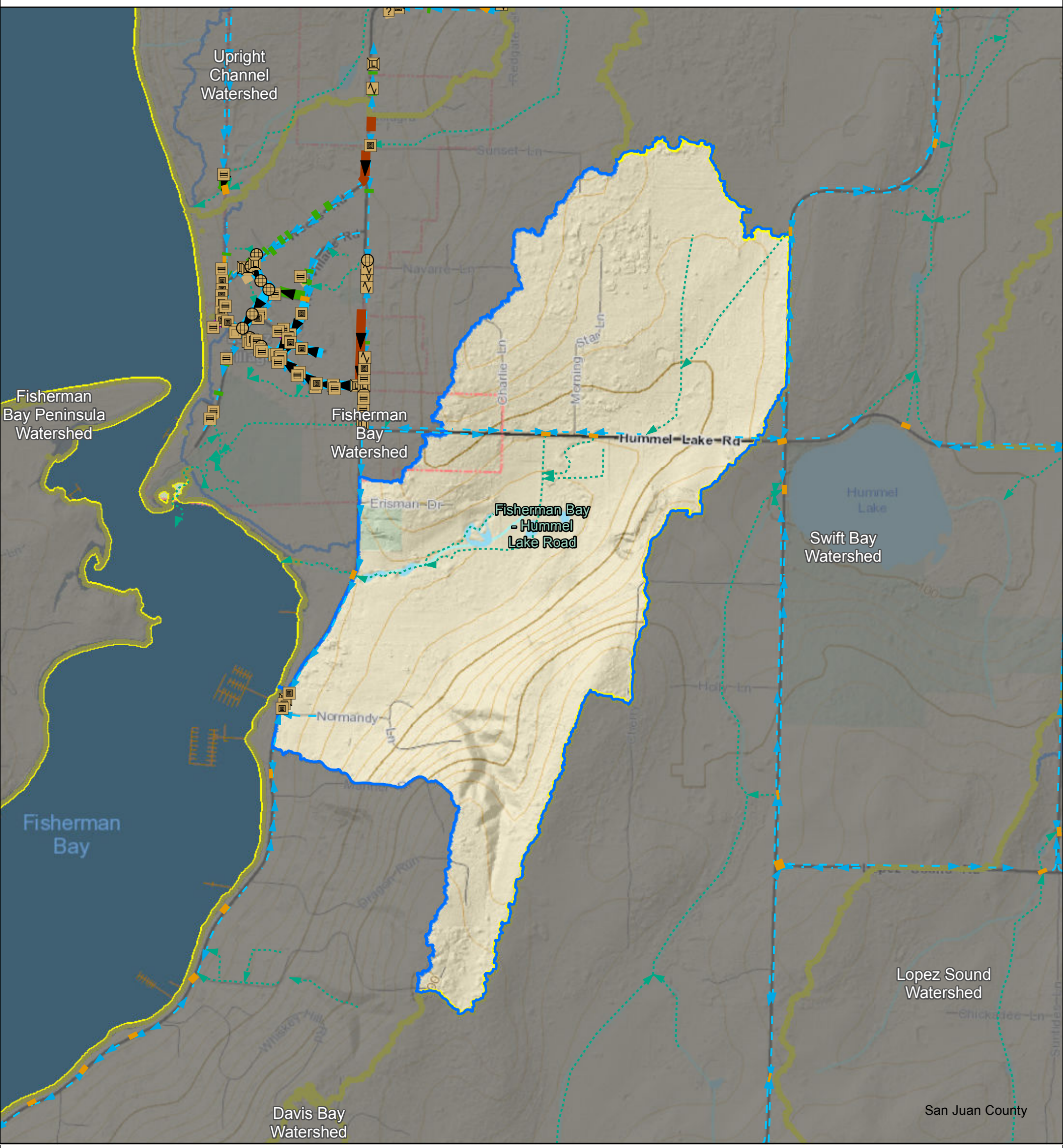
Figure 94:
Fisherman Bay Watershed Basin 1
Lopez Village

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:08 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 900 feet

0 1,100 Feet

Figure 95:
Fisherman Bay Watershed Basin 2
Hummel Lake Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:12 AM



SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 — 780 Feet

Figure 96:
Overview of Fisherman Bay Peninsula Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:28 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 200 feet

0 — 260 Feet

Figure 97:

Fisherman Bay Peninsula Watershed Basin 1
Peninsula Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:18 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,400 feet

0 1,200 Feet

Figure 98:
Overview of Hughes Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:32 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 1,000 Feet

Figure 99:

Hughes Bay Watershed Basin 1

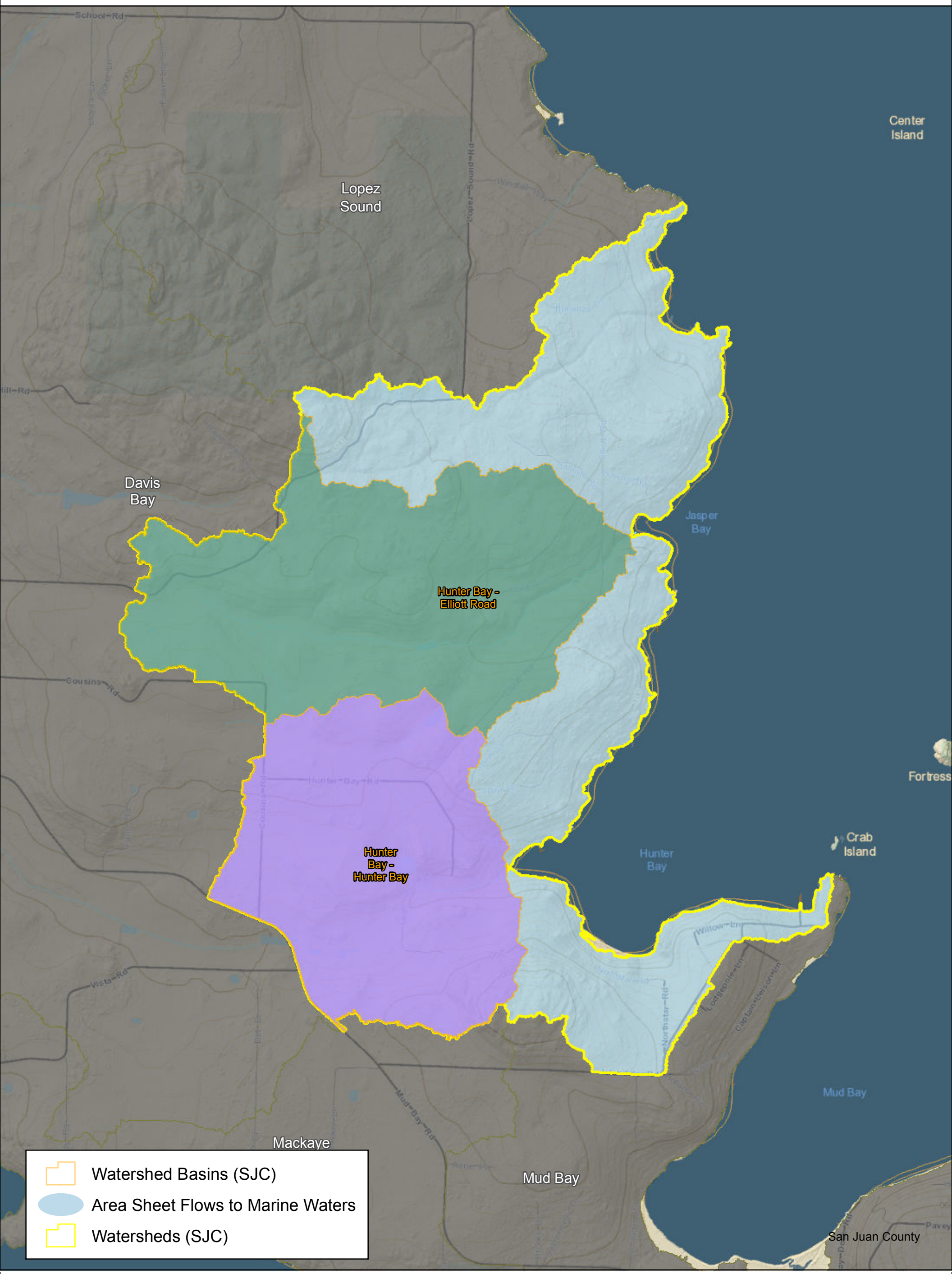
Hughes Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:23 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,200 feet

0 Feet 1,200

Figure 100:
Overview of Hunter Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:36 AM

Lopez Sound Watershed

Davis Bay Watershed

Hunter Bay - Elliott Road

Hunter Bay Watershed

Hunter Bay

San Juan County

Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 1,000 Feet

Figure 101:

Hunter Bay Watershed Basin 1
Elliott Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:26 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

Figure 102:
Hunter Bay Watershed Basin 2
Hunter Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:32 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,200 feet

0 1,200 Feet

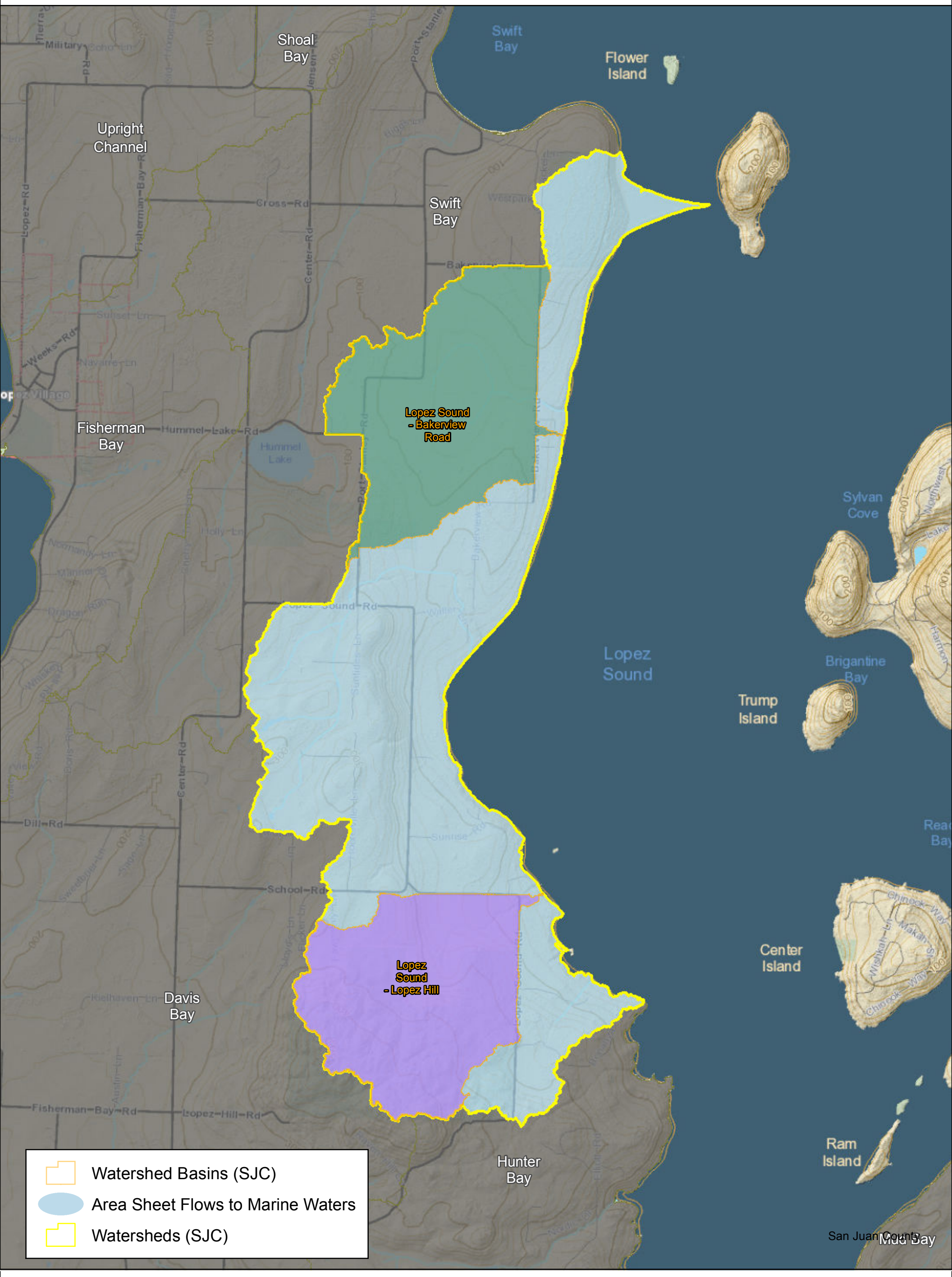
Figure 103:
Overview of Iceberg Point Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:39 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,000 feet

Feet
0 1,200 2,400

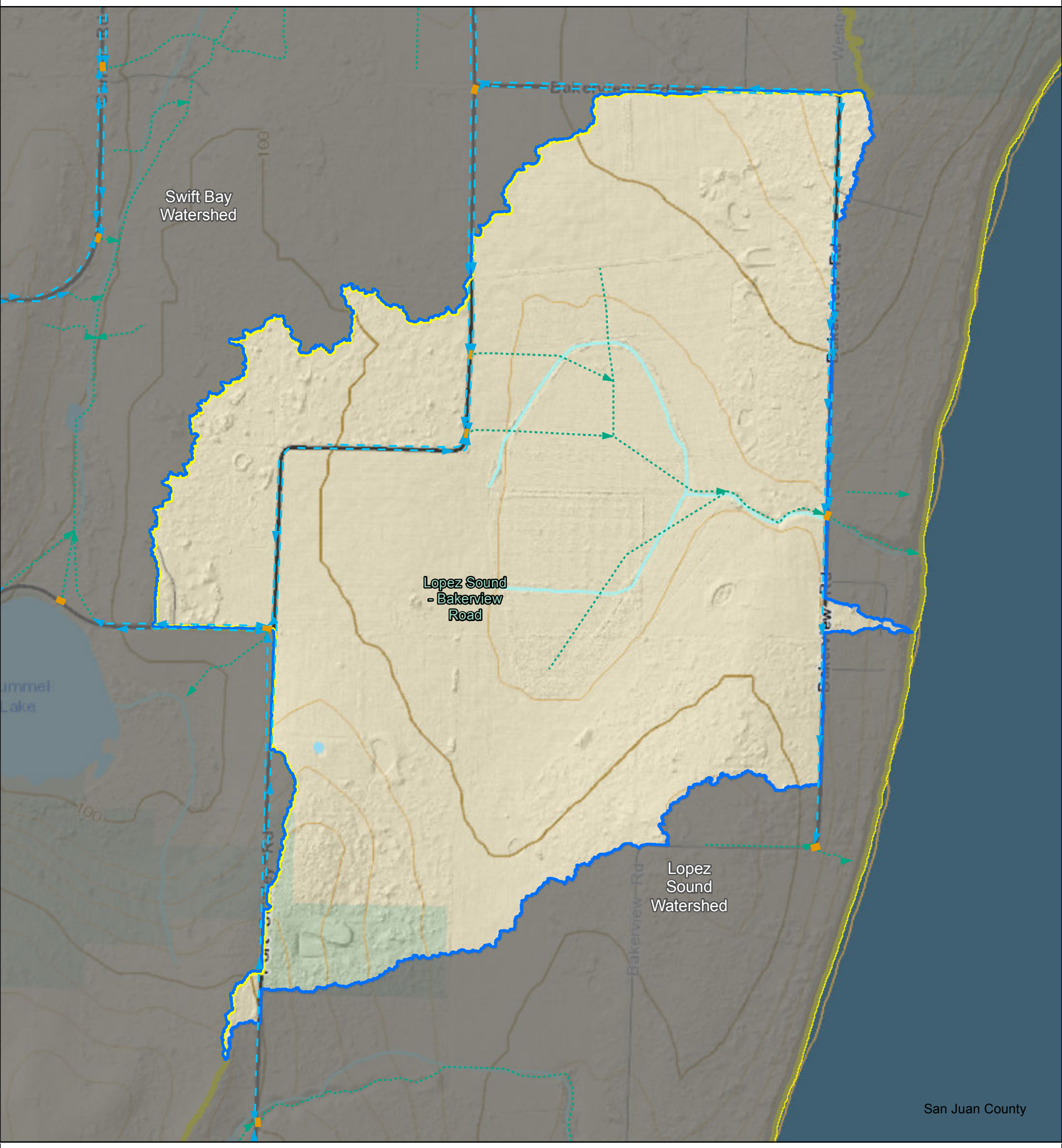
Figure 104:
Overview of Lopez Sound Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:42 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 — 920 Feet

Figure 105:
Lopez Sound Watershed Basin 1
Bakerview Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:36 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 700 feet

0 — 920 Feet

Figure 106:
Lopez Sound Watershed Basin 2
Lopez Hill

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:40 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,800 feet

Feet
0 1,200

Figure 107:
Overview of Mackaye Harbor Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:45 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 — 780 Feet

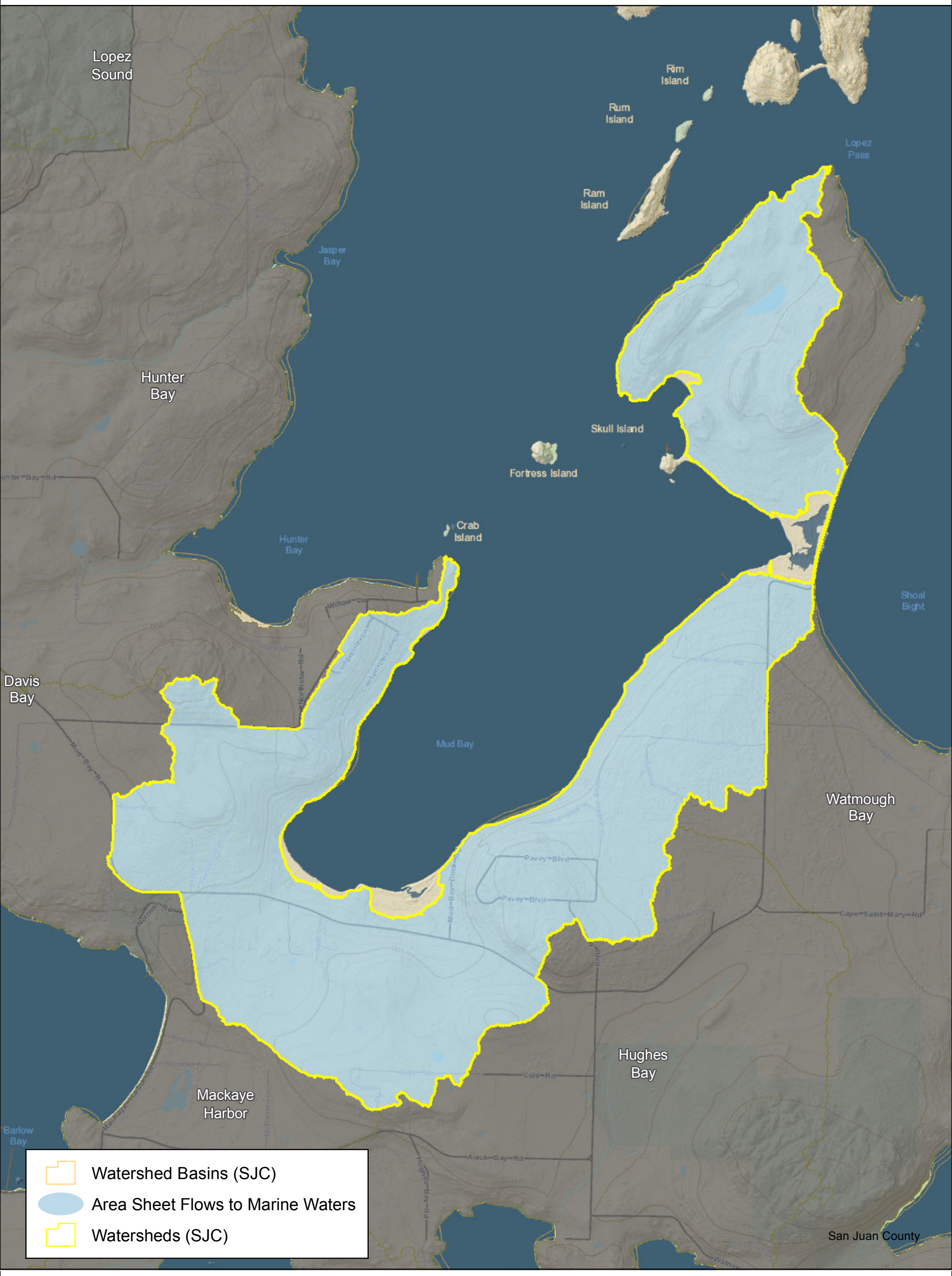
Figure 108:
Mackaye Harbor Watershed Basin 1
Mackaye Harbor Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:44 AM



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1 in = 1,400 feet

0 1,200 Feet

Figure 109:
Overview of Mud Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:48 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 400 feet

0 Feet 520

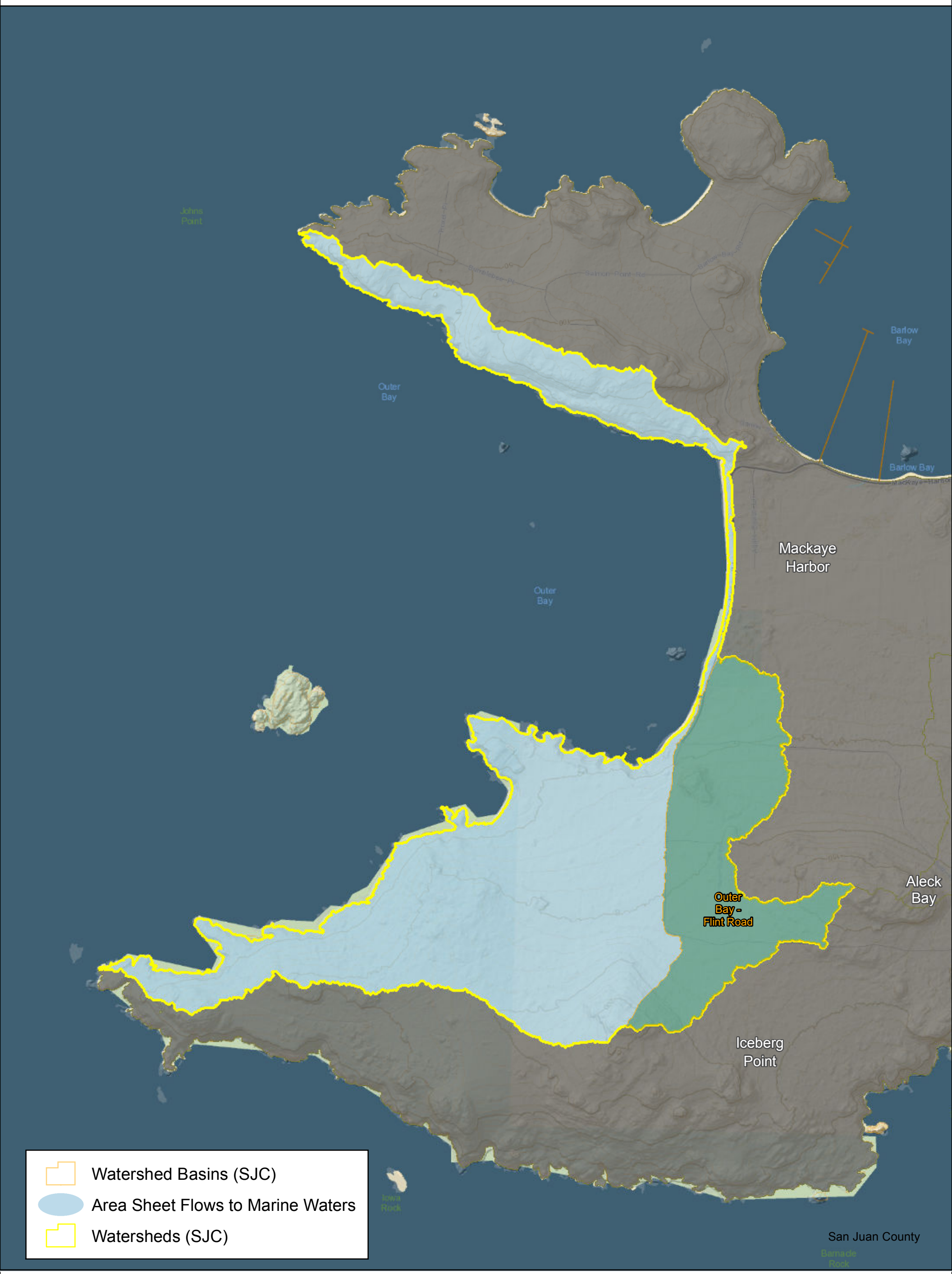
Figure 110:
Mud Bay Watershed Basin 1 Mud Bay Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:48 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 600 feet

0 780 Feet

Figure 111:
Overview of Outer Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:53 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 — 390 Feet

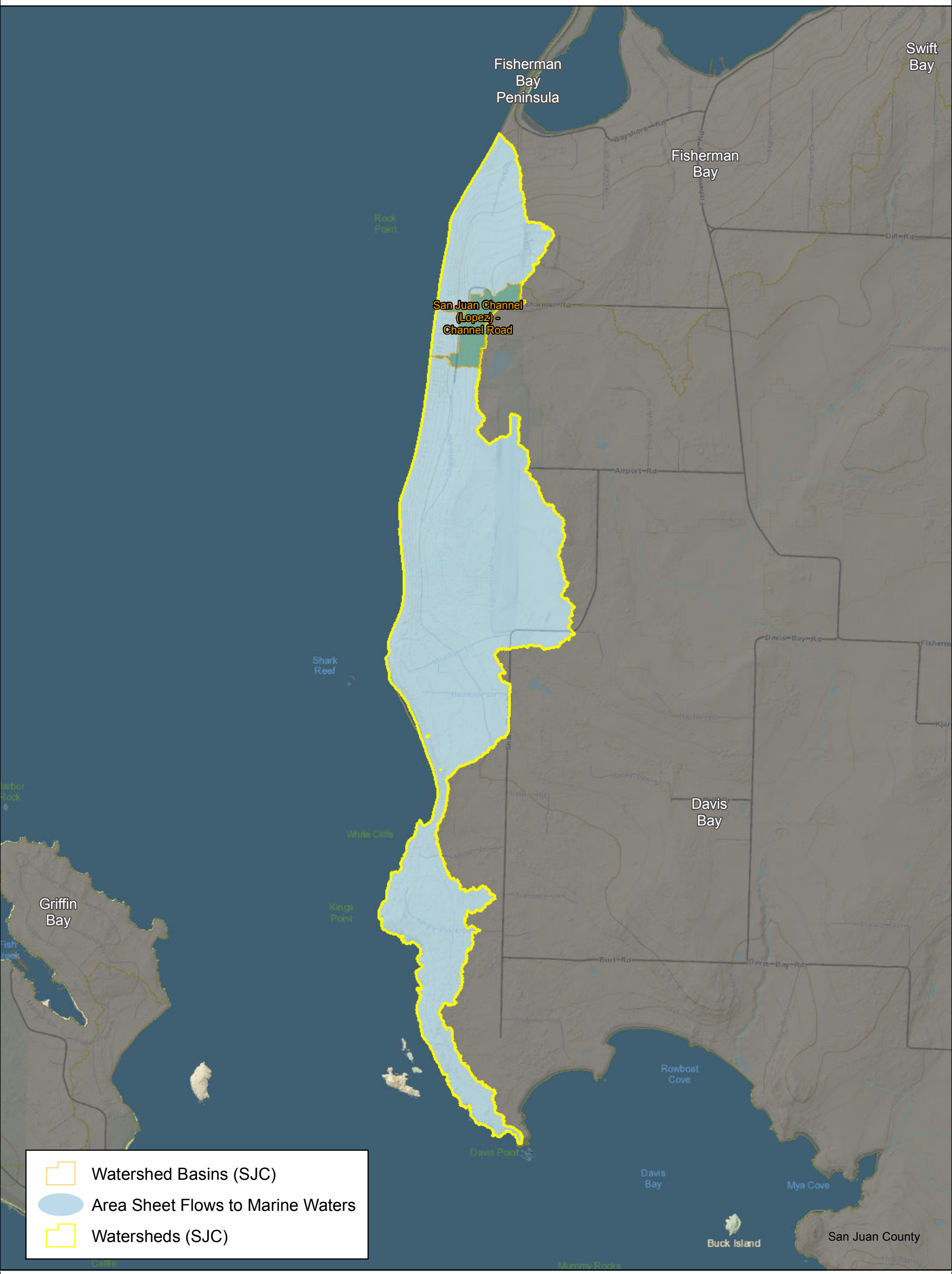
Figure 112:
Outer Bay Watershed Basin 1
Flint Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:50 AM



SAN JUAN COUNTY WASHINGTON

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1 in = 1,400 feet

Feet
0 1,200

Figure 113:
Overview of San Juan Channel (Lopez) Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:04:58 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 200 feet

0 260 Feet

Figure 114:

San Juan Channel (Lopez) Watershed Basin 1
Channel Road

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:56 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,000 feet

0 — 1,200 Feet

Figure 115:
Overview of Shoal Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:05:02 AM



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1 in = 700 feet

0 — Feet — 920

Figure 116:
Shoal Bay Watershed Basin 1
Shoal Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:11:59 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

Cross Culvert
Ditchline Culvert
French Drain
Other
Storm Lateral
Storm Main

Structure Type

Checkdam
Drop Structure
Other
Standard Inlet
Type 1 Catch Basin
Type 1L Catch Basin
Type 2 Catch Basin
Unknown
Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 100 feet

0 130 Feet

Figure 117:
Shoal Bay Watershed Basin 2
Ferry Landing

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:04 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,000 feet

Feet
0 1,200 2,400

Figure 118:
Overview of Swift Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:05:06 AM



SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,800 feet

Feet
0 1,200

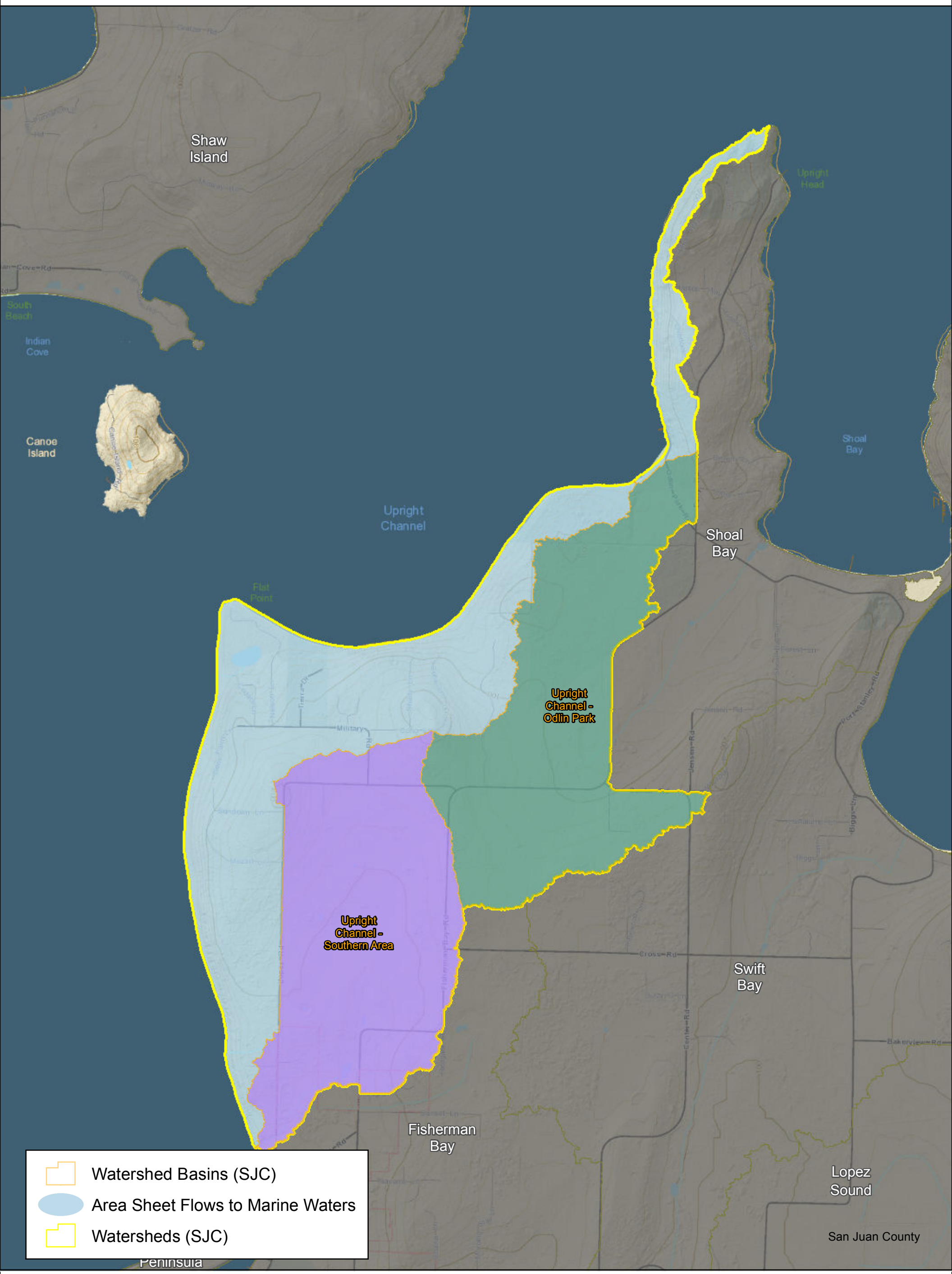
Figure 119:
Swift Bay Watershed Basin 1
Hummel Lake

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:09 AM



SAN JUAN COUNTY WASHINGTON

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,400 feet

0 — 1,200 Feet

Figure 120:
Overview of Upright Channel Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:05:10 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 800 feet

0 — 1,000 Feet

Figure 121:
Upright Channel Watershed Basin 1
Odlin Park

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:14 AM



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1 in = 700 feet

0 — 920 Feet

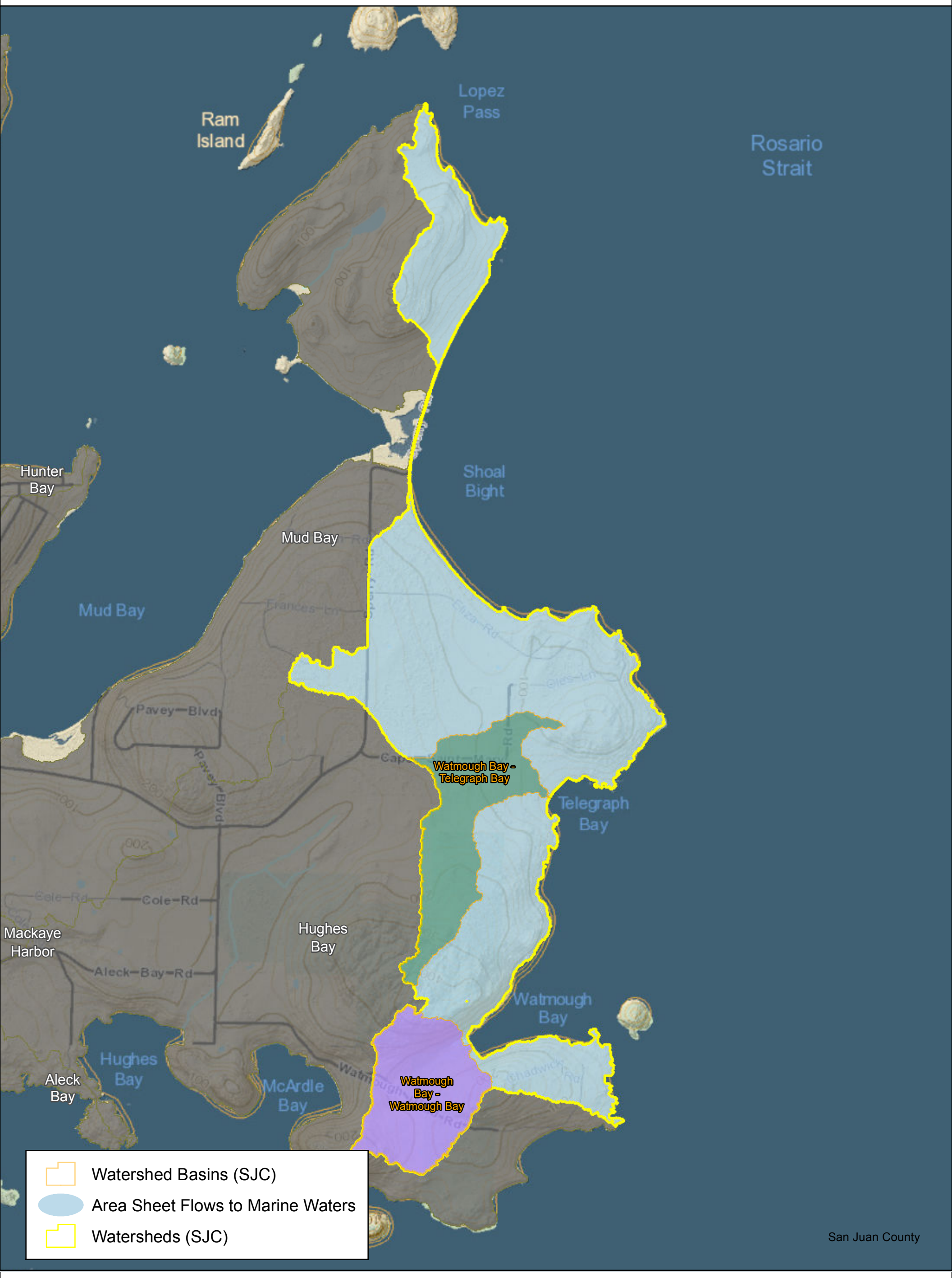
Figure 122:
Upright Channel Watershed Basin 2 Southern Area

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:18 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,600 feet

Feet
0 1,200

Figure 123:
Overview of Watmough Bay Watershed

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:05:13 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 500 feet

0 650 Feet

Figure 124:
Watmough Bay Watershed Basin 1
Telegraph Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:23 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 300 feet

0 — 390 Feet

Figure 125:
Watmough Bay Watershed Basin 2
Watmough Bay

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:27 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 3,200 feet

Feet
0 1,200 2,400 3,600

Figure 126:

Overview of Shaw Island Watershed

Basins within this watershed are generally described

but not yet delineated.

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Overviews of Watersheds.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 10:05:16 AM



Watershed Basins (SJC)
Watersheds (SJC)
Stormwater Flowlines
Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,500 feet

0 Feet 1,200

Figure 127:

Populated Outer Islands Watershed Basin 1
Henry Island

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:33 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,000 feet

0 1,200 2,400 Feet

Figure 128:

Populated Outer Islands Watershed Basin 2
Stuart Island

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:30 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,800 feet

0 1,200 Feet

Figure 129:

Populated Outer Islands Watershed Basin 3
Waldron Island

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:37 AM



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 2,200 feet

0 1,200 2,400 Feet

Figure 130:

Populated Outer Islands Watershed Basin 4
Blakely Island

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:40 AM



Watershed Basins (SJC)

Watersheds (SJC)

Stormwater Flowlines

Stormwater Ditches

Pipe Class

- Cross Culvert
- Ditchline Culvert
- French Drain
- Other
- Storm Lateral
- Storm Main

Structure Type

- Checkdam
- Drop Structure
- Other
- Standard Inlet
- Type 1 Catch Basin
- Type 1L Catch Basin
- Type 2 Catch Basin
- Unknown
- Wingwall

This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

1 in = 1,700 feet

0 1,200 Feet

Figure 131:

Populated Outer Islands Watershed Basin 5

Decatur Island

Path: O:\Projects\Stormwater Outreach\SW Basin Planning\Maps\Watershed Basins.mxd

Drawn By: Nick Peihl

Date: 6/3/2014

Time: 11:12:44 AM

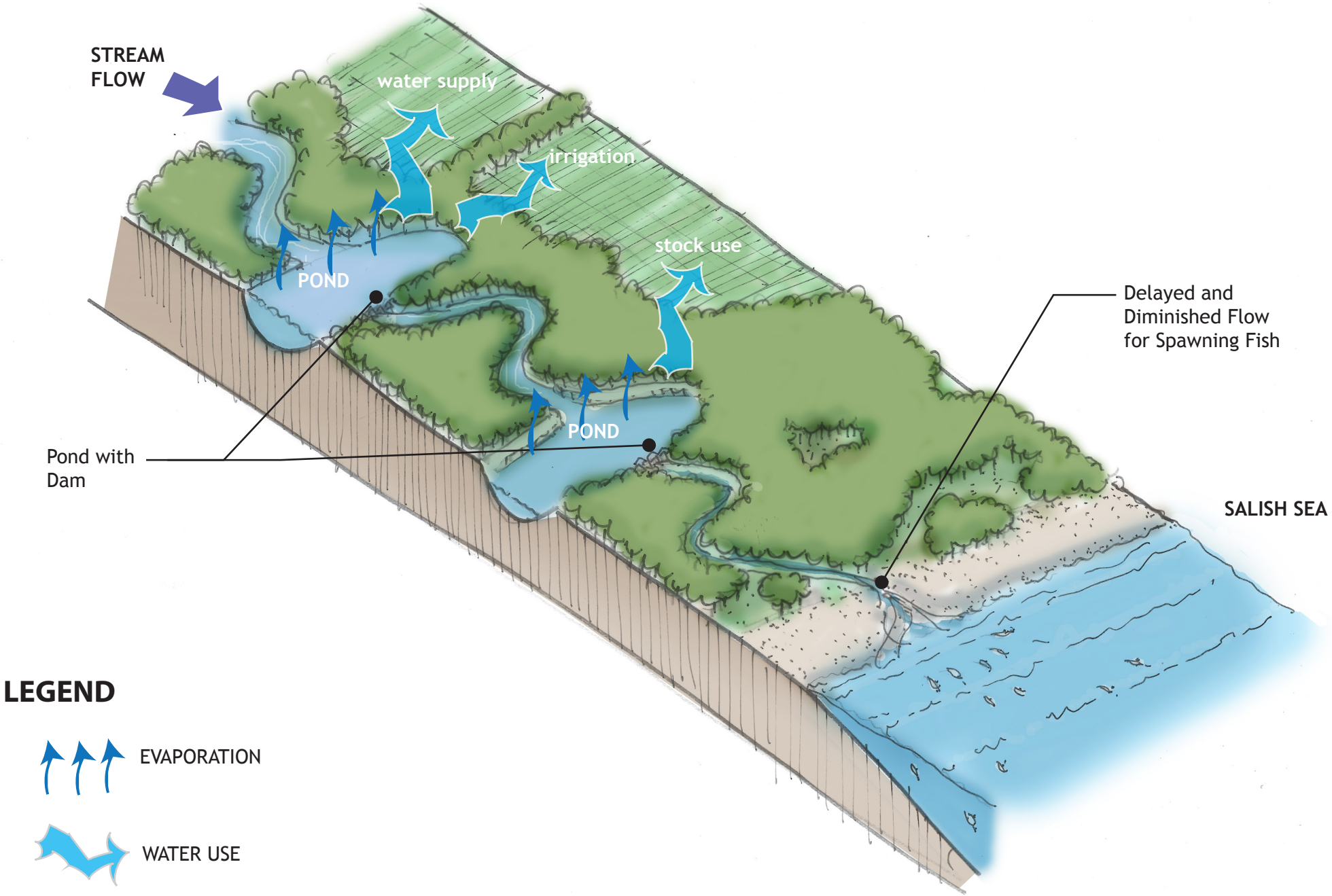


Figure 132. Illustration of How Instream Ponds can Delay and Diminish Stream Flows.

APPENDIX A

Geologic and Soil Information

Geology

The San Juan Islands lie along the northern edge of the Puget Lowland, which is a topographic and structural depression between the Olympic Mountains and the Cascade Range (Russell 1975). The core of the islands consist primarily of sedimentary and metamorphic bedrock.

The topography of the islands was shaped during the Pleistocene, as repeated glaciations scoured the bedrock of the region over a period of 2.4 million years (Blunt et al. 1987). The "Puget Lobe" (Bretz 1913) of the Cordilleran ice sheet covered the San Juan Islands between 18,200 and 13,300 years ago and reached a maximum thickness of 4,000 feet 17,000 years ago, during the last pulse of the most recent ice age (Porter and Swanson 1998). The ice sheet and subglacial meltwater streams cut channels in the existing bedrock of the region, carved outcrops, and shaped and rounded other landforms, mantling the bedrock in some locations with younger, clastic deposits, which are the primarily the product of glaciation and consist of till, drift, gravels, sands, clays, and silts.

Though glacial sediments cover much of the islands' surface, bedrock is either at the surface or at a shallow depth just below the near-surface soils over much of the island. Mechanical and chemical weathering processes have altered the near-surface bedrock to colluvium, which in some locations has been re-worked by glacial processes and is mixed with glacial sediments. In these areas, depth to bedrock is shallow.

Following the retreat of the Vashon-age ice sheet, streams incised through outwash sediments. Mass-wasting deposits of landslides and colluvium (small incoherent deposits from upper slopes) are common along the margins of the incised drainages. Post-glacial streams created relatively steep slopes that expose pre-Vashon-age sediments in the valley walls. Narrow bands of alluvium have been deposited within stream channels, and are composed mainly of sand and gravel. Wetlands are present throughout San Juan County, particularly in closed depressions in the drift plains.

There are multiple geologic maps that cover the San Juan Islands due to the large spatial extent of the County. The San Juan Islands have been mapped primarily at a 1:100,000 scale (Logan 2003; Lapen 2000; Pessl 1989), with a limited area of 1:24,000 mapping (Dethier 1996). See Table A-1 for a comprehensive list of geologic units mapped in the subject area. In general, the geology includes bedrock units, glacial deposits, and post-glacial deposits, as described below.

Bedrock Geology

Bedrock is the primary constituent of the San Juan Islands, despite a veneer of glacial sediments overlying some portions of the land. The geologic history and origination of the islands is somewhat controversial, but structural geologists generally agree that the islands share a similar history to much of western Washington (Brown et al. 2007; Cowan et al. 1997).

The Juan de Fuca tectonic plate is currently subducting under the North American plate in an easterly direction. Approximately 100 to 500 million years ago (Ma) it was doing the same, though the plate was much larger and carried on it islands and other micro-continents. These terranes, less dense than the ocean floor, sheared off the Juan de Fuca plate during

subduction and accreted onto the existing landmass of North America. The San Juan region was accreted onto the North American plate during the Late Cretaceous, about 80 to 120 Ma (Brown et al. 2007).

The San Juan Islands today are the result of this accretionary process. Faulted and sheared thrust systems making up the island present a complicated geologic story. The bedrock consists of 250 to 100 million-year-old fractured sedimentary and metasedimentary rock, with some isolated wedges of igneous rock. Bedrock materials are highly variable in a limited spatial extent; limestones, ocean-floor basaltic igneous rocks, schists, cherts, and other highly metamorphosed assemblages of sedimentary and igneous rocks comprise the islands (Russell 1975).

Glacial Geology (Pleistocene)

Surficial geologic conditions within the San Juan Islands are primarily the result of multiple periods of continental glaciation. In addition to carving the bedrock of the Islands, the ice sheet left its mark on the landscape in the form of numerous sequences of glacial sediment deposits. During each glacial advance and retreat, rivers emanating from the ice sheet deposited thick sequences of coarse-grained material (glacial outwash). Where the ice sheet overrode the glacial outwash, a thick sequence of dense, low permeability basal lodgement till (an unsorted mixture of sand, silt, clay, and gravel) was deposited on top of the outwash (Booth et al. 2003).

Where seawater came into or under the ice causing the ice sheet to float, generally fine-grained, low permeability glaciomarine drift was deposited. The glaciomarine drift is generally comprised of fine sand, silt, and clay with some lenses of sand and gravel. The ice sheets disrupted drainage systems and caused rivers to back up and form large lakes. These lake sediments (lacustrine) consist of fine sands and silts. During the time period between glaciations (non-glacial periods), the Puget Lowland was likely much like today, with primarily low-energy deposition occurring within floodplains, sedimentation in lakes, wetlands, bogs and streams, weathering of existing soils, and occasional large lahars or other volcanic events.

A sequence of silt/clay which overlies the bedrock in most places on the San Juan Islands correlates closely with the till deposited during the most recent glacial episode, the Vashon Stade of the Fraser Glaciation. In some places, there is a sequence of sands and gravels overlying the till. These sands and gravels, where present, correlate with the recessional outwash of the Vashon Stade and the Everson Interstade of the Fraser Glaciation, which gradually merge with the post glacial processes described below. Glaciomarine drift is limited to the north end of San Juan Island and parts of Shaw Island, and is identifiable in the field by the presence of marine fossils (Russell 1975; Logan 2003).

Post-Glacial Geology (Holocene)

As the ice retreated from the San Juan Islands the land mass rose above sea level due to isostatic rebound as the ice mass melted, and wave, wind, and stream action started reshaping the area. As the ice receded from the area, seawater returned and wave-cut terraces, sea cliffs, spits, and other coastal features were sculpted and formed from the easily eroded sediments, forming the modern shoreline. Elastic rebound of the islands also

occurred, at which time streams started downcutting their channels and depositing the material in lakes along their watercourse, gradually filling them and causing the lakes to become marsh or swamp land. Where the streams emptied into the salt water, deltas were formed, often creating salt marshes. Other Holocene deposits include modern stream alluvium and wetland deposits.

Geologically Hazardous Critical Areas

Geologic hazards that exist in San Juan County were evaluated by the County as part of a Critical Areas Ordinance Update. The update went into effect March 31, 2014. Geologically Hazardous Areas are mapped based on sloping ground, historic instability, groundwater seepage zones, or a combination of factors, and are defined by code as "*those areas that are susceptible to erosion, sliding, earthquake, or other geological events and are not suited to the siting of commercial, residential, or industrial development consistent with public health and safety concerns.*"

In San Juan County, geologic hazards have been divided into three categories according to probability of hazardous geologic activity occurring and potential consequences to people and property:

- **Category I – Landslide and Other Hazards:**
    - Areas designated in the Ecology Coastal Zone Atlas as U (Unstable), UB (Unstable Bluff), URS (Unstable Recent Slide), or UOS (Unstable Old Slide) and other areas identified by site-specific geologic reports
    - Areas with slopes of greater than 50 percent and with a vertical relief of 20 feet or more, except areas of exposed, unfractured bedrock. If any portion of a slope meets this definition, the slope, or some larger portion may be designated a landslide hazard area.
    - Areas designated as Quaternary slumps, earthflows, mudflows, or landslides on maps published by the United States Geological Survey or the Washington Department of Natural Resources
- **Category II – Erosion, Landslide, and Other Hazards**:
    - Erosion hazard areas characterized by soils identified in the USDA Soil Survey of San Juan County, Soil Survey Washington as having severe water a high risk of erosion, with a land capability subclass of "e."
    - Any area with all three of the following characteristics:
        - Slopes in excess of 15 percent
        - Pervious soil layers overlying semi-pervious to impervious soil layers
        - Evidence of springs or groundwater seepage to the surface

- Mine Hazards: Areas directly underlain or affected by mine workings including steep and unstable slopes created by open mines. Mine hazard areas are based upon the identification of active or historic mining activity and site-specific information regarding topography and geology provided by the applicant as needed.

- **Category III – Seismic Hazards**:

  - San Juan County in its entirety is located within Seismic Design Category D_1 of the International Building Code and the International Residential Code.

Liquefaction susceptibility zones identified in the Washington Department of Natural Resources Liquefaction Susceptibility Map

Soils

The Soil Survey of San Juan County generalizes soils by categorizing them into one of five characteristic settings: valleys of glacial drift plains, glacial drift plains, hills of glacial drift plains, glacial drift plains and hills, and hills and mountains. Each setting is described by representative soil types within it. The Soil Survey also tabulates the percentage of San Juan County belonging to each setting (NRCS 2005). Table A-2 summarizes this information.

The bedrock and glacial history of the San Juan Islands have played an important role in the development of surface soils, and subsequently strongly influences both county- and basin-scale soil hydrologic properties. Soils in San Juan County are formed over relatively young glacial deposits or glaciated bedrock surfaces and have not had sufficient time to develop the deep weathering profiles present in soils of many unglaciated terrains. That translates into few areas of the County having deep soil profiles with high infiltration capacity. The great variability in bedrock translates to a wide variety of mapped soil units, with over 50 units mapped in San Juan County by the NRCS, and each unit consisting of one to three soil types. Characteristics of all soil types, such as depth to restrictive layer, drainage class, permeability, depth to water table, surface erosion factor, and geologic parent material, are summarized in Table A-3.

Soils in San Juan County have been mapped by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS). Soil scientists create the surveys by observing the steepness, shape, and length of slopes, the general pattern of drainage, vegetation, and the kinds of bedrock. They dig holes to study soil profiles down to the parent material below the rooting zone of the vegetation to soil that has not been changed by biological activity (NRCS 2005). The soils are then grouped into map units of similar characteristics including depth to restrictive layer, drainage class, and depth to water table.

Five major types of soil parent material are found in San Juan County— glacial outwash, glacial drift, fine-grained glaciomarine deposits, colluvium derived from marine metasedimentary rock, and post-glacial deposits associated with beach or decomposed plant material. The majority of San Juan County soils fall in one of these five parent materials that define many of the soils' properties. Additions of organic material, eolian sediment, and airfall deposits of volcanic ash sometimes are mixed with the soil near the surface.

1. **Soils Derived from Glacial Outwash**: Soils with glacial outwash as a parent material consist of San Juan, Hoypus, Everett, Keystone, and Indianola. Drainage into these soils is generally very good and ponding does not usually occur.

2. **Soils Derived from Glacial Drift**: Bazal, Mitchellbay, and Roche soils are representative of those that consist of glacial drift or shallow glacial outwash over water-restrictive, fine-grained glaciomarine deposits. During the wetter months of the year (October through May), a perched water table develops above the fine-grained glaciomarine deposits. In nearly level to gently sloping areas, the perched water table reaches the surface and water may pond on the soil during periods of frequent precipitation.

3. **Soils Derived from Fine-Grained Glaciomarine Deposits**: Fine-grained glaciomarine deposits are a common parent material for County soils and also frequently underlie outwash or drift soil units. There are no NRCS soil units specifically mapped as glaciomarine deposits. However, geologic maps of the area map glaciomarine deposits throughout the San Juan Islands (Dethier 1996).

4. **Soils Derived from Marine Metasedimentary Rock Colluvium**: Cady, Doebay, Haro, and Turtleback soils are representative of those that consist of colluvium mixed with glacial drift. These soils are in areas of thin glacial sediment or in areas where the sediment has been eroded. A bedrock contact is typically within two feet of the surface (NRCS 2005). Bedrock in San Juan County, from which the latter soils are derived, is typically marine metasedimentary rock of the Cretaceous- Jurassic period (Logan 2003).

5. **Soils Derived from Post-Glacial Deposits:** Post-glacial deposits were deposited during the Holocene and include beach/tidal soils, Orcas Peat, Shalcar muck, and Semiahmoo muck. They are predominantly in areas of high-groundwater.

Hydrologic Soil Groups

Soils are classified by the NRCS into four Hydrologic Soil Groups (HSGs) based on soil runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Group A soils generally have the smallest runoff potential and Group D soils the greatest runoff potential. These ratings can also be generally equated to infiltration potential, with Group A soils having the greatest, and Group D soils, the lowest potential. Further descriptions of these soil groups are discussed below.

- **HSG Type A**: Soils within Soil Group A are the most likely candidates to act as receptor soils for long-term infiltration. Group A soils typically have a high infiltration rate and consist mainly of deep, well drained to excessively drained sands or gravelly sands, and as such, have low runoff potential and a high rate of water transmission. In San Juan County, glacial outwash, eolian sands, and beach sands are classified as HSG Type A.

- **HSG Type B**: Group B soils typically have a moderate infiltration rate and depth, are fairly well drained, and have a fine texture to coarse texture. These soils have moderate runoff potential and a moderate rate of water transmission. Coarser-grained

glacial drift and thin glacial outwash overlying drift typically fall into this category. Some peat deposits and drift mixed with colluvium derived from the weathering of bedrock are also classified as Group B but would not be considered as having a high infiltration potential.

- **HSG Type C**: Group C soils typically have a slow infiltration rate. These soils generally have moderately fine or fine textured restrictive layers that impede the downward movement of water. In storm events, there is moderately high runoff potential. These soils have a slow rate of water transmission, and typically consist of glacial drift over fine-grained deposits or mixed with soil that is the weathering byproduct of bedrock.

- **HSG Type D**: Group D soils typically have a very slow infiltration rate and consist of relatively thin, very fine-grained material that have a high water table and overlie nearly impervious material. These soils have a very slow rate of water transmission and have high runoff potential. In the San Juan Islands, this type consists of bedrock and glacial drift or fine-grained glaciomarine deposits mixed with soil that is the weathering byproduct of bedrock.

- **HSG Dual Type**: Group B/D and C/D soils are naturally Group D soils, primarily due to a high water table, or shallow depth to dense or fine-grained, non-infiltrative soils that may have characteristics of Group B or C soils if drained.

HSG Group A Soil Units with Potential for Long-Term Infiltration

Soils within Soil Group A are the most likely candidates to act as receptor soils for long-term infiltration. A brief description and properties of these soils follow. Group A soils that are already saturated, such as beach and tidal deposits, are not described in this section.

- **San Juan Sandy Loam (Group A) 3005, 3006, 3007***:* The San Juan sandy loam is a deep, somewhat excessively drained soil derived from eolian sand over glacial outwash, and associated with hill slopes (NRCS 2005). It has a high capacity to transmit water and a depth to seasonal high water table of more than 72 inches. It varies from sandy loam at the surface to extremely gravelly coarse sand at about 2.3 feet depth.

- **Everett Sandy Loam (Group A) 3013, 3014***:* The Everett sandy loam is a deep, somewhat excessively drained soil associated with drift plains in the San Juan Islands (NRCS 2005). It is derived from glacial outwash, has a high capacity to transmit water and a depth to seasonal high water table of more than 72 inches. It varies from sandy loam at the surface to extremely gravelly coarse sand at 2.5 feet depth.

- **Hoypus Sandy Loam (Group A) 3001***:* The Hoypus sandy loam is a deep, somewhat excessively drained soil found on drift plains in the San Juan Islands (NRCS 2005). It is derived from glacial outwash, has a high capacity to transmit water and a depth to seasonal high water table of more than 72 inches. It varies from sandy loam at the surface to extremely gravelly sand at 3 feet depth.

- **Indianola Loamy Sand (Group A) 3015***:* The Indianola loamy sand is a deep, somewhat excessively drained soil found on drift plains (NRCS 2005). It is derived from glacial outwash, has a high capacity to transmit water and a depth to seasonal high water

table of more than 72 inches. It varies from loamy sand at the surface to sand at 3 feet depth.

- **Keystone Sandy Loam (Group A) 3002***:* The Keystone sandy loam is a deep, somewhat excessively drained soil derived from glacial outwash and found on drift plains (NRCS 2005). It has a high capacity to transmit water and a depth to seasonal high water table of more than 72 inches. The Keystone varies between sandy loam and loamy sand to a depth of 5 feet.

- **Sucia Loamy Sand (Group A/D) 2002***:* The Sucia loamy sand is a shallow (20 to 40 inches to infiltration-restrictive material), moderately well drained soil derived from glacial outwash over fine-grained glaciomarine deposits and found on drift plains (NRCS 2005). It has a moderately high capacity to transmit water and a depth to seasonal high water table of about 12 to 20 inches. Soil composition varies from a loamy sand at the surface, to a gravelly loamy sand at 2 feet, and to a silt loam at 3 feet depth. Due to a shallow depth to fine-grained material, the Sucia would more likely be a candidate for dispersed rather than point infiltration and infiltration feasibility would strongly depend on adequate soil thickness.

- **Sucia-Sholander complex (Group A/D) 3016***:* The Sucia-Sholander complex consists about 50 percent Sucia soils, 40 percent Sholander soils, and 10 percent miscellaneous soils. Both Sucia and Sholander are derived from glacial outwash over dense glaciomarine deposits. The complex is associated with drift plains. Drainage ranges from moderately well drained (Sucia) to somewhat poorly drained (Sholander). Depth to seasonal high water table and depth to restrictive material vary. The complex generally has a high capacity to transmit water (NRCS 2005). Due to variability of hydrologic properties within the complex, infiltration into this unit may be feasible in some areas.

HSG Group B Soil Units with Potential for Long-Term Infiltration

Soils within Soil Group B are sometimes candidates for long-term infiltration, depending on slope, depth to fine-grained material underlying the soil, and height of the seasonal high water table. Group B soils formed on slopes greater than 20 percent or highly organic soils ("muck" or "peat") are not described in this section. Additionally, the following soil units are classified as B/D but are not described in this section as they include finer-grained drift units that are less suitable for infiltration: Alderwood-Everett complex (2007), Limepoint-Alderwood-Sholander complex (2009), Whidbey-Hoypus complex (2010), Whidbey gravelly loam (2000), Alderwood-Hoypus complex (4006).

- **Sholander Gravelly Loam (Group B/D) 1002***:* The Sholander gravelly loam is a moderately deep (40 to 60 inches to fine-grained material), somewhat poorly drained soil derived from glacial outwash over fine-grained glaciomarine deposits and found on drift plains (NRCS 2005). It has a variable capacity to transmit water and a depth to seasonal high water table of about 4 to 12 inches. Soil composition varies from a gravelly loam at the surface, to a gravelly sand at 2.5 feet, and to a loam at 4 feet depth. Due to a shallow depth to water table, the Sholander would more likely be a

candidate for dispersed rather than point infiltration and infiltration feasibility would depend on site-specific conditions.

- **Laconner gravelly sandy loam (Group B/D) 4002***:* The Laconner gravelly sandy loam is a shallow (20 to 40 inches to fine-grained material), moderately well drained soil derived from glacial outwash over fine-grained glaciomarine deposits and found on drift plains (NRCS 2005). It has a variable capacity to transmit water and a depth to seasonal high water table of about 12 to 20 inches. Soil composition is primarily a gravelly sandy loam, with varying amounts of fine-grained materials. Due to a shallow depth to fine-grained material, the Laconner would more likely be a candidate for dispersed rather than point infiltration and infiltration feasibility would depend on site-specific conditions.

Erosion Potential

Erosion hazard areas include areas likely to become unstable and are primarily identified by their slope and soil type. Erosion factors for each soil type are noted within the NRCS Soil Survey as the K factor. Erosion factor K indicates the susceptibility of a soil to erosion by water and is influenced by the soil's texture, structure, amount and type of organic matter, and permeability. Soils high in clay content often have low K values because they are resistant to detachment and therefore do not easily erode. Soils high in silt content are highly erodible and have high K values. Sandy soils, such as outwashes, allow water to infiltrate rather than run overland, and therefore generally have low K values (NRCS 2005). For soils in San Juan County, silty, steeply sloping, unconsolidated glacial drift deposits underlain at shallow depths by bedrock are the most susceptible to erosion hazard, and have the highest K value. Gently sloping, deep, and well-drained glacial outwash soils are least susceptible to erosion hazard.

Erosion is not solely determined by the soil type but also by environmental factors such as vegetation, landform shape, slope gradient and length, precipitation, groundwater conditions, and land use and development.

Table A-1. List of Geologic Units Mapped in San Juan County.				
Geologic Map	**Map Scale**	**Map Author**	**Map Unit**	**Name of Mapped Unit**
Port Townsend	1:100k	Pessl	Qd	Dune Deposits (Holocene)
			Qb	Beach Deposits (Holocene)
			Qtf	Tidal-Flat Deposits (Holocene)
			Ql	Landslide Deposits (Holocene and Pleistocene)
			Qm	Marsh, Bog, or Swamp Deposits (Holocene)
			Qvrm	Recessional-Marine Deposits (Pleistocene)
			Qvrc	Recessional -Continental Deposits (Pleistocene)
			Qvt	Till (Pleistocene)
			Qfu	Glacial and Nonglacial Sedimentary Deposits of Fraser Glaciation, Undivided (Pleistocene)
			Qu	Glacial and Nonglacial Sedimentary Deposits , Undivided (Pleistocene)
			br	Bedrock
Roche Harbor	1:100k	Logan	Qa	Alluvium (Holocene)
			Qp	Peat Deposits (Holocene)
			Qls	Landslide Deposits (Holocene)
			Qb	Beach Deposits (Holocene)
			Qgds	Drift, Sumas Stade (Pleistocene)
			Qgdmes	Glaciomarine subtidal deposits, Everson Interstade (Pleistocene)
			Qgdme	Glaciomarine drift, Everson Interstade (Pleistocene)
			Qgog	Outwash gravel, Vashon Stade (Pleistocene)
			Qgt	Till, Vashon Stade (Pleistocene)
			Qgd	Drift, Vashon Stade (Pleistocene)
			Qguc	Undifferentiated deposits (Pleistocene)
			br	Bedrock (Cretaceous-Pre-Devonian)
Bellingham	1:100k	Lapen	Qb	Beach Deposits (Holocene)
			Qgd	Glacial deposits, undifferentiated (Pleistocene)
			Qgome	Marine outwash, Everson Interstade (Pleistocene)
			Qgt	Glacial till, Vashon Stade (Pleistocene)
			Qga	Advance outwash, Vashon Stade (Pleistocene)
			br	Bedrock (Cretaceous-Pre-Devonian)
False Bay, Friday Harbor	1:24k	Dethier	f	Fill
			Qd	Dune Deposits (Holocene)
			Qb	Beach Deposits (Holocene)
			Qtf	Tidal-Flat Deposits (Holocene)
			Ql	Landslide Deposits (Holocene)
			Qm	Marsh, Bog, or Swamp Deposits (Holocene)
			Qvrme	Emergence deposits, Vashon Stade (Pleistocene)
			Qvrms	Marine subtidal deposits, Vashon Stade (Pleistocene)
			Qvrmd	Marine diamicton, Vashon Stade (Pleistocene)
			Qvrmo	Marine outwash, Vashon Stade (Pleistocene)
			Qvt	Till, Vashon Stade (Pleistocene)
			Qvd	Diamicton, undifferentiated, Vashon Stade (Pleistocene)
			Qva	Advance outwash, Vashon Stade (Pleistocene)
			Qpfn	Nonglacial deposits (Pleistocene)
			br	Bedrock

Table A-2. Summary of General Soil Map Unit Characteristics				
Location	**Soil Types**	**Parent Materials**	**Percentage of County**	**Depth Class**
Valleys of Glacial Drift Plains	Coveland-Deadmanbay-Bazal	Glacial drift, glacial outwash, dense glaciomarine deposits, colluvium, and organic material	19	Moderately deep and deep
Glacial Drift Plains	Mitchellbay-Whidbey-Roche	Glacial drift, glacial outwash, and dense glaciomarine deposits	20	Shallow to very deep
Hills of Glacial Drift Plains	Everett Taxadjunct-Indianola-San Juan	Glacial drift, glacial outwash, and dense glaciomarine deposits	7	Moderately deep and very deep
Glacial Drift Plains and Hills	Roche-Rock outcrop-Killebrew	Glacial drift, glacial outwash, colluvium, and dense glaciomarine deposits	9	Shallow to very deep
Hills and Mountains	Cady-Rock outcrop-Doebay	Glacial drift and colluvium	45	Shallow and moderately deep

Table A-3. Characteristics of San Juan County Soils from National Resource Conservation Service.

Group Rating	Map Unit Symbol	Map Soil Unit Name	Soil Type Component	Landform	Parent Material	Slope (%)	Depth to Seasonal High Water (in)	Drainage Class	Depth to Restrictive Feature (in)	Capacity to Transmit Water
A	3001	Hoypus sandy loam, 3 to 25 percent slopes		Hillslopes	Glacial outwash	3 to 25	>72	Somewhat excessively drained	>60	High or very high
A	3007	San Juan sandy loam, 5 to 20 percent slopes		Hillslopes	Eolian sand over glacial outwash	5 to 20	>72	Somewhat excessively drained	>60	High or very high
A	3002	Keystone sandy loam, 5 to 15 percent slopes		Hillslopes	Glacial outwash	5 to 15	>72	Somewhat excessively drained	>60	High or very high
A	3005	San Juan sandy loam, 2 to 8 percent slopes		Hillslopes	Eolian sand over glacial outwash	2 to 8	>72	Somewhat excessively drained	>60	High or very high
A	3010	San Juan-Dune land complex, 0 to 20 percent slopes	San Juan	Dunes, blowouts	Eolian sand over glacial outwash	0 to 20	>72	Somewhat excessively drained	>60	High or very high
			Dune Land	Dunes	Eolian sand over glacial outwash	0 to 20	>72	Somewhat excessively drained	>60	High or very high
A	3012	Hoypus sandy loam, 10 to 40 percent slopes		Hillslopes	Glacial outwash	10 to 40	>72	Excessively drained	>60	Very high
A	4003	Hoypus-Whidbey complex, 10 to 30 percent slopes	Hoypus	Hillslopes	Glacial outwash	10 to 30	>72	Somewhat excessively drained	>60	High or very high
			Whidbey	Hillslopes	Glacial drift over fine-grained glacial drift	10 to 20	12 to 20	Moderately well drained	20 to 40	Low to very high
A	3015	Indianola loamy sand, warm, 3 to 15 percent slopes		Hillslopes	Glacial outwash	3 to 15	>72	Somewhat excessively drained	>60	High or very high
A	3013	Everett sandy loam, warm, 3 to 20 percent slopes		Hillslopes	Glacial outwash	3 to 20	>72	Somewhat excessively drained	>60	High or very high
A/D	3016	Sucia-Sholander complex, 5 to 20 percent slopes	Sucia	Valleys	Glacial outwash over fine-grained glaciomarine deposits	5 to 20	12 to 20	Moderately well drained	20 to 40	High to very high
			Sholander	Valleys	Glacial outwash over fine-grained glaciomarine deposits	5 to 20	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
A/D	2002	Sucia loamy sand, 2 to 10 percent slopes		Valleys	Glacial outwash over fine-grained glaciomarine deposits	2 to 10	12 to 20	Moderately well drained	20 to 40	Mod. high to very high
B/D	2007	Alderwood-Everett complex, warm, 5 to 15 percent slopes	Alderwood	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	5 to 15	12 to 20	Moderately well drained	20 to 40	Low to high
			Everett, warm	Hillslopes	Glacial outwash	5 to 15	>72	Somewhat excessively drained	>60	High or very high
B/D	2009	Limepoint-Alderwood, warm-Sholander complex, 2 to 12 percent slopes	Limepoint	Drainageways & valleys	Glacial drift over fine-grained glaciomarine deposits	2 to 5	0 to 8	Poorly drained	40 to 60	Low to very high
			Alderwood, warm	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	3 to 12	12 to 20	Moderately well drained	20 to 40	Low to high
			Sholander	Valleys	Glacial outwash over fine-grained glaciomarine deposits	3 to 12	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
B/D	2010	Whidbey-Hoypus complex, 2 to 15 percent slopes	Whidbey	Hillslopes	Glacial drift over fine-grained glacial drift	2 to 10	12 to 20	Moderately well drained	20 to 40	Low to very high
			Hoypus	Hillslopes	Glacial outwash	5 to 15	>72	Somewhat excessively drained	>60	High or very high
B/D	2000	Whidbey gravelly loam, 3 to 15 percent slopes		Hillslopes	Glacial drift over fine-grained glacial drift	3 to 15	12 to 20	Moderately well drained	20 to 40	Low to very high
B/D	1002	Sholander gravelly loam, 2 to 8 percent slopes		Valleys	Glacial outwash over fine-grained glaciomarine deposits	2 to 8	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
B/D	4002	Laconner gravelly sandy loam, warm, 5 to 15 percent slopes		Hillslopes	Glacial outwash over fine-grained glaciomarine deposits	5 to 15	12 to 20	Moderately well drained	20 to 40	Low to very high
B/D	4006	Alderwood, warm-Hoypus complex, 5 to 20 percent slopes	Alderwood, warm	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	5 to 20	12 to 20	Moderately well drained	20 to 40	Low to high
			Hoypus	Hillslopes	Glacial outwash	5 to 20	>72	Somewhat excessively drained	>60	High or very high

Table A-3 (continued). Characteristics of San Juan County Soils from National Resource Conservation Service.

Group Rating	Map Unit Symbol	Map Soil Unit Name	Soil Type Component	Landform	Parent Material	Slope (%)	Depth to Seasonal High Water (in)	Drainage Class	Depth to Restrictive Feature (in)	Capacity to Transmit Water
C	5003	Doebay-Morancreek complex, 5 to 25 percent slopes	Doebay	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	5 to 25	>72	Well drained	20 to 40	Moderately high or high
			Morancreek	Mountain slopes & Hillslopes	Glacial drift	5 to 25	16 to 28	Moderately well drained	>60	High
C	5015	Doebay, moist-Cady-Rock Outcrop complex, 10 to 30 percent slopes	Doebay	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	10 to 30	>72	Well drained	20 to 40	Moderately high or high
			Cady	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	10 to 30	>72	Well drained	10 to 20	Moderately high or high
			Rock Outcrop		Rock	10 to 30				
C/D	1000	Sholander-Spieden complex, 0 to 5 percent slopes	Sholander	Valleys	Glacial outwash over fine-grained glaciomarine deposits	0 to 5	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
			Spieden	Drainageways	Glacial outwash	0 to 2	0 to 8	Poorly drained	>60	Mod. high to very high
C/D	1001	Coveland loam, 0 to 5 percent slopes		Hillslopes & valleys	Glacial drift over fine-grained glaciomarine deposits	0 to 5	0 to 8	Somewhat poorly drained	40 to 60	Low to high
C/D	1003	Coupeville loam, 0 to 5 percent slopes		Valleys	Glacial drift over fine-grained glaciomarine deposits	0 to 5	0 to 8	Poorly drained	40 to 60	Low to high
C/D	1004	Limepoint-Sholander complex, 0 to 8 percent slopes	Limepoint	Valleys & Drainageways	Glacial drift over fine-grained glaciomarine deposits	0 to 5	0 to 8	Poorly drained	40 to 60	Low to very high
			Sholander	Valleys	Glacial outwash over fine-grained glaciomarine deposits	2 to 8	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
C/D	1009	Coveland-Mitchellbay complex, 2 to 15 percent slopes	Coveland	Hillslopes & valleys	Glacial drift over fine-grained glaciomarine deposits	2 to 10	4 to 12	Somewhat poorly drained	40 to 60	Low to high
			Mitchellbay	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	5 to 15	4 to 12	Somewhat poorly drained	20 to 40	Low to high
C/D	1010	Deadmanbay-Morancreek complex, 2 to 15 percent slopes	Deadmanbay	Drainageways & valleys	Glacial drift over fine-grained glaciomarine deposits	2 to 8	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
			Morancreek	Mountain slopes & Hillslopes	Glacial drift	5 to 15	16 to 28	Moderately well drained	>60	High
C/D	1013	Bazal-Mitchellbay complex, 0 to 5 percent slopes	Bazal	Drainageways & valleys	Glacial drift over fine-grained glaciomarine deposits	0 to 2	0 to 8	Poorly drained	20 to 40	Low to very high
			Mitchellbay	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	0 to 5	0 to 8	Somewhat poorly drained	20 to 40	Low to high
C/D	1015	Deadmanbay-Bazal-Cady complex, 2 to 20 percent slopes	Deadmanbay	Drainageways	Glacial drift over fine-grained glaciomarine deposits	5 to 15	4 to 12	Poorly drained	40 to 60	Low to very high
			Bazal	Drainageways	Glacial drift over fine-grained glaciomarine deposits	2 to 5	0 to 8	Poorly drained	20 to 40	Low to very high
			Cady	Hillslopes & mountain slopes	Colluvium derived from glacial drift and metasedimentary rock	10 to 20	>72	Well drained	10 to 20	Moderately high or high
C/D	4007	Roche-Mitchellbay complex, 3 to 15 percent slopes	Roche	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	5 to 15	12 to 20	Moderately well drained	20 to 40	Low to high
			Mitchellbay	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	3 to 8	4 to 12	Somewhat poorly drained	20 to 40	Low to high
C/D	4008	Mitchellbay-Rock Outcrop-Killebrew complex, 3 to 15 percent slopes	Mitchellbay	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	3 to 8	4 to 12	Somewhat poorly drained	20 to 40	Low to high
			Rock Outcrop		Rock	3 to 15				
			Killebrew	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	3 to 8	4 to 12	Somewhat poorly drained	20 to 40	Low to high
C/D	2001	Mitchellbay gravelly sandy loam, 5 to 15 percent slopes		Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	5 to 15	4 to 12	Poorly drained	20 to 40	Low to high

Table A-3 (continued). Characteristics of San Juan County Soils from National Resource Conservation Service.

Group Rating	Map Unit Symbol	Map Soil Unit Name	Soil Type Component	Landform	Parent Material	Slope (%)	Depth to Seasonal High Water (in)	Drainage Class	Depth to Restrictive Feature (in)	Capacity to Transmit Water
C/D	4005	Roche-Haro-Rock Outcrop complex, 5 to 25 percent slopes	Roche	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	5 to 15	12 to 20	Moderately well drained	20 to 40	Low to very high
			Haro	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	5 to 25	>72	Well drained	10 to 20	Moderately high to very high
			Rock Outcrop		Rock	5 to 25				
C/D	2004	Mitchellbay gravelly sandy loam, 0 to 5 percent slopes		Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	0 to 5	0 to 8	Somewhat poorly drained	20 to 40	Low to high
C/D	2008	Mitchellbay-Sholander-Bazal complex, 0 to 8 percent slopes	Mitchellbay	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	2 to 8	4 to 12	Somewhat poorly drained	40 to 60	Low to high
			Sholander	Valleys	Glacial outwash over fine-grained glaciomarine deposits	2 to 8	4 to 12	Somewhat poorly drained	40 to 60	Low to very high
			Bazal	Drainageways & valleys	Glacial drift over fine-grained glaciomarine deposits	0 to 2	0 to 8	Poorly drained	20 to 40	Low to very high
C/D	2011	Roche-Killebrew complex, 2 to 10 percent slopes	Roche	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	2 to 10	12 to 20	Moderately well drained	20 to 40	Low to high
			Killebrew	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	2 to 10	4 to 12	Somewhat poorly drained	20 to 40	Low to high
C/D	3000	Pilepoint loam, 2 to 8 percent slopes		Hillslopes	Eolian sand over glacial outwash and fine-grained glaciomarine deposits	2 to 8	12 to 20	Moderately well drained	20 to 40	Low to very high
D	5007	Haro-Hiddenridge-Rock Outcrop complex, 5 to 30 percent slopes	Haro	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	5 to 30	>72	Well drained	10 to 20	Moderately high to very high
			Hiddenridge	Mountain slopes & Hillslopes	Glacial drift mixed with colluvium derived from metasedimentary rock	5 to 15	>72	Well drained	40 to 60	High or very high
			Rock Outcrop		Rock	5 to 30				
D	5000	Cady-Rock Outcrop complex, 5 to 30 percent slopes	Cady	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary	5 to 30	>72	Well drained	10 to 20	Moderately high or high
			Rock Outcrop		Rock	5 to 30				
A	3006	San Juan sandy loam, 20 to 40 percent slopes		Hillslopes	Eolian sand over glacial outwash	20 to 40	>72	Somewhat excessively drained	>60	High or very high
A	3014	Everett sandy loam, warm, 20 to 40 percent slopes		Hillslopes	Glacial outwash	20 to 40	>72	Excessively drained	>60	Very high
A	5010	Turtleback-Cady-Rock Outcrop complex, 25 to 75 percent slopes	Turtleback	Mountain slopes & Hillslopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	40 to 60	High or very high
			Cady	Mountain slopes & Hillslopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	10 to 20	Moderately high or high
			Rock Outcrop		Rock	25 to 75				
B	5004	Pickett-Kahboo-Rock Outcrop complex, 25 to 75 percent slopes	Pickett	Mountain slopes & Hillslopes	Glacial drift mixed with colluvium derived from metasedimentary rock and volcanic ash	25 to 75	>72	Well drained	20 to 40	High
			Kahboo	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock and volcanic ash	25 to 75	>72	Well drained	10 to 20	Moderately high or high
			Rock Outcrop		Rock					

Table A-3 (continued). Characteristics of San Juan County Soils from National Resource Conservation Service.

Group Rating	Map Unit Symbol	Map Soil Unit Name	Soil Type Component	Landform	Parent Material	Slope (%)	Depth to Seasonal High Water (in)	Drainage Class	Depth to Restrictive Feature (in)	Capacity to Transmit Water
C	5008	Doebay-Cady-Rock Outcrop complex, 10 to 30 percent slopes	Doebay	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	10 to 30	>72	Well drained	20 to 40	Moderately high or high
			Cady	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	10 to 30	>72	Well drained	10 to 20	Moderately high or high
			Rock Outcrop		Rock	10 to 30				
C	5002	Doebay, moist-Cady-Doebay complex, 25 to 75 percent slopes	Doebay, moist	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	20 to 40	Moderately high or high
			Cady	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	10 to 20	Moderately high or high
			Doebay	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	20 to 40	Moderately high or high
C/D	4000	Roche-Killebrew-Rock Outcrop complex, 5 to 35 percent slopes	Roche	Hillslopes	Glacial drift over fine-grained glaciomarine deposits	5 to 15	12 to 20	Moderately well drained	20 to 40	Low to high
			Killebrew	Valleys & valleysides	Glacial drift over fine-grained glaciomarine deposits	5 to 15	4 to 12	Somewhat poorly drained	20 to 40	Low to high
			Rock Outcrop		Rock	10 to 35				
D	5006	Cady-Doebay-Rock Outcrop complex, 25 to 75 percent slopes	Cady	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	10 to 20	Moderately high or high
			Doebay	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	20 to 40	Moderately high or high
			Rock Outcrop		Rock					
D	5009	Haro-Hiddenridge-Rock Outcrop complex, 25 to 75 percent slopes	Haro	Mountain slopes & Hillslopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	10 to 20	Moderately high to very high
			Hiddenridge	Mountain slopes & Hillslopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 50	>72	Well drained	40 to 60	High or very high
			Rock Outcrop		Rock	25 to 75				
	1014	Beaches-Endoaquents, tidal-Xerorthents association, 0 to 5 percent slopes	Beaches	Beaches	Beach sand	0 to 5	0	n/a	>60	n/a
			Endoaquents, tidal	Beaches	Beach sand	0 to 2	0	Very poorly drained	>60	Very high
			Xerothents	Hillslopes & beaches	Beach sand and colluvium derived from glacial outwash	0 to 5	>72	Excessively drained	>60	Very high
A	3008	Xerorthents-Endoaquents, tidal association, 0 to 100 percent slopes	Xerothents	Hillslopes, sea cliffs, beaches	Beach sand and colluvium derived from glacial outwash	5 to 100	>72	Excessively drained	>60	Very high
			Endoaquents	Beaches	Beach sand	0 to 5	0	Very poorly drained	>60	Very high
	5001	Rock Outcrop-Haro complex, 25 to 75 percent slopes	Rock Outcrop		rock	25 to 75				
			Haro	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock	25 to 75	>72	Well drained	10 to 20	Moderately high to very high

Table A-3 (continued). Characteristics of San Juan County Soils from National Resource Conservation Service.

Group Rating	Map Unit Symbol	Map Soil Unit Name	Soil Type Component	Landform	Parent Material	Slope (%)	Depth to Seasonal High Water (in)	Drainage Class	Depth to Restrictive Feature (in)	Capacity to Transmit Water
B/D	1016	Orcas peat, 0 to 2 percent slopes		Depressions	Slightly decomposed plant material	0 to 2	0	Very poorly drained	>60	Moderately high or high
B	5005	Constitution-Skipjack-Kahboo complex, 5 to 25 percent slopes	Constitution	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock and volcanic ash	5 to 25	>72	Well drained	20 to 40	High
			Skipjack	Hillslopes & mountain slopes	Glacial drift and volcanic ash	5 to 15	36 to 48	Well drained	>60	Moderately high or high
			Kahboo	Hillslopes & mountain slopes	Glacial drift mixed with colluvium derived from metasedimentary rock and volcanic ash	5 to 25	>72	Well drained	10 to 20	Moderately high or high
B/D	1005	Shalcar muck, 0 to 2 percent slopes		Depressions	Highly decomposed plant material over glacial outwash or fine-grained glaciomarine deposits	0 to 2	0 to 8	Very poorly drained	16 to 51	Moderately high to very high
C/D	1006	Semiahmoo muck, 0 to 2 percent slopes		Depressions	Highly decomposed plant material with a thin layer of volcanic ash mixed with diatomaceous earth	0 to 2	0 to 8	Very poorly drained	>60	Moderately high or high

APPENDIX B

Methods for Land Use Determination and Buildout Impervious Area Calculations

Existing Land Use Methodology

The following steps were taken to document existing land use in each of the San Juan County basins.

1. Existing land use categories were derived from the 2013 San Juan County Assessor's parcel data by converting the 2 digit "Use_Code" field to their corresponding land use categories. For example, the 2 digit code for residential is 10. Two digit codes 11 through 19 are subcategories that represent different types of residential uses (11 means household, single family units). There are 8 general land use categories and 82 subcategories. The codes are listed below:

10	**Residential**	**60**	**Services**
11	Household, single family units	61	Finance, insurance, and real estate services
12	Household, 2-4 units	62	Personal services
13	Household, multi-units (5 or more)	63	Business services
14	Residential hotels - condominiums	64	Repair services
15	Mobile home parks or courts	65	Professional services
16	Hotels/motels	66	Contract construction services
17	Institutional lodging	67	Governmental services
18	All other residential not elsewhere coded	68	Educational services
19	Vacation and cabin	69	Miscellaneous services
20, 30	**Manufacturing**	**70**	**Cultural, Entertainment and Recreational**
21	Food and kindred products	71	Cultural activities and nature exhibitions
22	Textile mill products	72	Public assembly
23	Apparel and other finished products made from fabrics, leather, and similar materials	73	Amusements
24	Lumber and wood products (except furniture)	74	Recreational activities
25	Furniture and fixtures	75	Resorts and group camps
26	Paper and allied products	76	Parks
27	Printing and publishing	77	Not presently assigned
28	Chemicals	78	Not presently assigned
29	Petroleum refining and related industries	79	Other cultural, entertainment, and recreational
30	Rubber and miscellaneous plastic products	**80**	**Resource Production and Extraction**
31	Leather and leather products	81	Agriculture (not classified under current use law)
32	Stone, clay and glass products	82	Agriculture related activities
33	Primary metal industries	83	Agriculture classified under current use chapter 84.34 RCW
34	Fabricated metal products	84	Fishing activities and related services
35	Professional scientific, and controlling instruments; photographic and optical goods; watches and clocks-manufacturing	85	Mining activities and related services
36	Not presently assigned	86	Not presently assigned
37	Not presently assigned	87	Classified forest land chapter 84.33 RCW
38	Not presently assigned	88	Designated forest land chapter 84.33 RCW
39	Miscellaneous manufacturing	89	Other resource production

40	**Transportation, Communication and Utilities**
41	Railroad/transit transportation
42	Motor vehicle transportation
43	Aircraft transportation
44	Marine craft transportation
45	Highway and street right of way
46	Automobile parking
47	Communication
48	Utilities
49	Other transportation, communication, and utilities not classified elsewhere
50	**Trade**
51	Wholesale trade
52	Retail trade - building materials, hardware, and farm equipment
53	Retail trade - general merchandise
54	Retail trade - food
55	Retail trade - automotive, marine craft, aircraft, and accessories
56	Retail trade - apparel and accessories
57	Retail trade - furniture, home furnishings and equipment
58	Retail trade - eating and drinking
59	Other retail trade

90	**Undeveloped land and water areas**
91	Undeveloped land
92	Noncommercial forest
93	Water areas
94	Open space land classified under chapter 84.34 RCW
95	Timberland classified under chapter 84.34 RCW
96	Not presently assigned
97	Not presently assigned
98	Not presently assigned
99	Other undeveloped land

2. Once the 2 digit codes were converted to their corresponding land use category, the parcels were organized by stormwater basin. Land use tables provided in the report show the amount of acres that correspond to each of the 8 generalized land use categories by stormwater basin. The percentage values are based on the total acres in each stormwater basin. Stormwater basins are based on the San Juan County 2012 watershed dataset.

3. The narrative preceding the tables provides a summary of the land uses that comprise the majority of the basin, i.e., that correspond to 75 percent of the basin based on the specific subcategories listed above. The land uses are described in order starting with the land use with the highest acreage in the basin and ending with the smallest.

Buildout Impervious Area Calculations Methodology

For each watershed, we estimated the percentage increase in future impervious cover resulting from full buildout. We started by calculating the percentage of existing impervious cover on fully developed tax parcels using the 2011 National Land Cover Dataset (NLCD). Since each tax parcel has a Land Use designation in the San Juan County Comprehensive Plan we can average the percentage of impervious cover for each Land Use designation. This land use impervious cover percentage was then applied to developable vacant and partially developed tax parcels to estimate future percentage of impervious cover for each parcel at full buildout. The future buildout estimates were then classified and summarized by watershed and compared with the existing impervious cover estimates to estimate the increase in impervious cover for each watershed.

The buildout impervious area estimates provided by this method are gross estimates that do not take into account setbacks, critical areas, buffers, and small waterbodies. Actual impervious area at buildout would likely be somewhat less than estimated here. Nevertheless, the estimate provides a relative measure that suggests which watersheds are at most risk from future stormwater problems.

References

San Juan County. 2012. Watershed GIS Data.

San Juan County. 2013. Tax Parcel GIS Data.

APPENDIX C

Stormwater Basin Planning Web Map Reports

Table C-1. Stormwater Issues.

Watershed	Stormwater Issue	Comments	Jurisdiction	Longitude	Latitude
Deer Harbor	Flooding	Overflowing drainage ditch on south side of Channel Rd, water over road	San Juan County	-123.0125008	48.6254128
Deer Harbor	Flooding	Water overflowing ditch on south side of Channel Rd. Water over the road.	San Juan County	-123.0159041	48.6264057
Deer Harbor	Flooding	flooding across road due to driveway flow not entering the ditch. Can we fix this with a right of way permit for a drainage structure	San Juan County	-122.9835786	48.60195565
Doe Bay	Flooding	Flooding over roadway after rains ever since CenturyLink contractor dug up corner to push new cable underground.	San Juan County	-122.7813772	48.64722591
Doe Bay	Private Property Damage	Drain ditches are overgrown. Water floods into neighboring field after each rain. Significant erosion.	San Juan County	-122.7798128	48.64722241
Eastsound	Erosion	Significant erosion of the bluff at this point where the abandoned County road used to be	San Juan County	-122.8856422	48.69075955
Eastsound	Erosion	There is a cross culvert in this area (it may be at the next drive to the south) and the area between here and the shore is eroding	San Juan County	-122.8837221	48.68876629
Eastsound	Erosion	Runoff crossing the road and is eroding the road itself	San Juan County	-122.8136205	48.61077667
Eastsound	Erosion	Water is eroding down the road and pooling at the lowest section. The puddles and potholes are ranging between 1' and 15' in diameter. and are averaging approximately 8" to 10" in depth. Traffic for most vehicles has to be routed down Palisades.	San Juan County	-122.8745069	48.64932469
Eastsound	Erosion	The road in front of our house suffers erosion and huge potholes. Fill disappears in weeks. We're advised that it's water coming downhill from Rosario Road above, and that an engineering design is needed to fix a complex problem.	San Juan County	-122.8747616	48.64973822
Eastsound	Erosion	Water is surfacing along Marina Heights Lane and causing substantial erosion damage to the surface of the road. The top of the road is becoming a ditch, despite repeated grading and gravel replacement.	San Juan County	-122.8623576	48.64299933
Eastsound	Erosion	Flows from a creek erode the road and threaten the utility installations along the road. This is the only access to the area.	San Juan County	-122.8555419	48.63424339
Eastsound	Erosion	Run off from Horseshoe Highway ditch has no where to go. A few years ago my neighbor and I installed a below ground drainage pipe to try to stop the erosion of the community access to the beach. This outflow caused serious erosion of my bank.	San Juan County	-122.8905365	48.69470381

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Eastsound	Erosion	recent development in this area on private roads. Water running directly on surface of the road and carrying sediment to County infrastructure on Rosario Rd	San Juan County	-122.8666936	48.65482202
Eastsound	Flooding	Surface drainage insufficient to contain water runoff from adjoining property, flooding access road and private yard during rains	San Juan County	-122.9098027	48.69536055
Eastsound	Flooding	Inadequate surface water management by neighboring development leads excess water to flood walking path used by multiple neighboring homes	San Juan County	-122.9101511	48.69549143
Eastsound	Flooding	Flooding and erosion into area of large potholes	San Juan County	-122.876229	48.64978265
Eastsound	Flooding	Water streaming across Rosario Road descends to Cascade Way, where erodes & damages road, then overflows bank to harm properties & roads below.	San Juan County	-122.8754315	48.65034381
Eastsound	Flooding	West side of Dolphin Bay Rd across from Martin Lake floods during periods of high rain fall.	San Juan County	-122.8964945	48.62079932
Eastsound	Flooding	Water streaming across Rosario Road descends to Cascade Way, where erodes & damages road, then overflows bank to harm properties & roads below.	San Juan County	-122.8754315	48.65034381
Eastsound	Flooding	Water streaming across Rosario Road descends to Cascade Way, where erodes & damages road, then overflows bank to harm properties & roads below.	San Juan County	-122.8754315	48.65034381
Eastsound	Flooding	Water streaming across Rosario Road descends to Cascade Way, where erodes & damages road, then overflows bank to harm properties & roads below.	San Juan County	-122.8754315	48.65034381
Eastsound	Flooding	Photo added of Flooding on Cascade Way	San Juan County	-122.8746848	48.64935156
Eastsound	Flooding	Flooding, ponding & erosion at low point on Cascade Way damages road and overflows to harm properties & roads downhill.	San Juan County	-122.8748364	48.64936855
Eastsound	Flooding	Flooding, ponding & erosion at low point on Cascade Way damages road and overflows to harm properties & roads downhill.	San Juan County	-122.8747591	48.64937563
Eastsound	Flooding	From the corner of Weber Lane and west on Mount Baker Road, the waters are pooling at 6" deep, 1,000LF long x 40LF' wide; water is coming into the property--it is muddy, swampy and inaccessible. Road edge has eroded and is a total disaster.	San Juan County	-122.9110143	48.69790721

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Eastsound	Flooding	During rainstorms, water pours down the north side of the road and pools on the road itself, then flows onto our property, flooding the carport, washing across our lawn and driveway, and rutting the access road.	San Juan County	-122.8751741	48.64888773
Eastsound	Nuisance	Flooding due to improper water discharge from neighboring property	San Juan County	-122.9098857	48.69543904
Eastsound	Other	This areas is suffering from some ponding and flooding of crawl spaces as well as road degradation. This area needs a multiple site evaluation.	San Juan County	-122.8747756	48.64943506
Eastsound	Other	Road degradation and water bars in this area appear to be inadequate to manage water from upland development	San Juan County	-122.8742671	48.64879278
Eastsound	Other	There is groundwater that surfaces on the NE side of the "Longhouse" driveway on Fern St that can freeze and make for an unsafe condition. EWUA has confirmed that this water is not a potable water leak.	San Juan County	-122.9050397	48.69599586
Eastsound	Other	Drainage pipe through the land bank property needs survey/ cleaning	San Juan County	-122.9100689	48.69447801
Eastsound	Ponding	This driveway is commonly ponding 2 inches or more of water.	San Juan County	-122.9008515	48.69464141
Eastsound	Ponding	Water flowing down Meyer 9% slope accumulates in corner. Water unable to cross road without flooding downstream Recent road work in Jan/2014 has exacerbated the problem.	San Juan County	-122.915963	48.69193794
Eastsound	Ponding	Ponding at the downhill side of the culvert under the driveway	San Juan County	-122.8663759	48.65221835
Eastsound	Ponding	Ditching problems along Rosario Road cause flooding that sometimes accumulates and/or crosses road to cause more problems further downhill.	San Juan County	-122.8663096	48.65224649
Eastsound	Ponding	Drainage ditches do not drain. Standing water for long periods until rain which causes overflow of surface water at various locations	San Juan County	-122.8880894	48.69340184
Eastsound	Ponding	Standing water in ditch. Does not drain	San Juan County	-122.8888468	48.69442238
Eastsound	Private Property Damage	Madrona street discharge is incomplete and floods all downstream properties	San Juan County	-122.9031299	48.6949796
Eastsound	Private Property Damage	Storm water entering from drain under Crow Valley road causes erosion and ponding on fields below.	San Juan County	-122.9361593	48.68061313

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Eastsound	Private Property Damage	Water runoff from Lovers Lane floods neighboring properties	San Juan County	-122.9112916	48.69616224
Eastsound	Private Property Damage	Significant financial damage caused by blocked stormwater drains.	San Juan County	-122.9056846	48.69468198
Eastsound	Private Property Damage	Water floods off of Grove Street and instead of going down Ocean Mist floods property below with water, mud and debris. Water also floods lower properties with drainage into Rosario harbor	San Juan County	-122.8739378	48.64845454
Eastsound	Private Property Damage	The intersection of the private road and County Road results in water running down the private rd. Requires frequent maintenance.	San Juan County	-122.8764948	48.64933425
Eastsound	Private Property Damage	County ditch water has nowhere to go. It needs to be diverted under the road and routed to the wetlands. This has been known by the county for years with no resolution	San Juan County	-122.8905336	48.69559498
Eastsound	Private Property Damage	We, the Board of Directors of the Rosario Property Owners Association (RPOA), wish to submit to the county's Stormwater Assessment Program our members' recent comments about stormwater problems in the Rosario portion of the East Sound drainage.	San Juan County	-122.8740409	48.64588569
False Bay	Erosion	Pond drainage directed to road ditch eroding the ditch	San Juan County	-123.0703225	48.49989893
False Bay	Erosion	Stormwater itself isn't causing a problem, but the ditch cleaning that's periodically done does cause erosion. A better idea would be to line the ditch with a drain line and cover it, eliminating the ditch, and any need to clean the ditch	San Juan County	-123.0835902	48.52570955
False Bay	Erosion	Large culvert eroding banks fish passage issues.	San Juan County	-123.0989338	48.54420505
False Bay	Other	Infrastructure related to a cross culvert and ditch design issues, above ground metal culvert, cross culvert rusted, flow around culvert road surface potholes	San Juan County	-123.0614811	48.48740131
False Bay	Ponding	This area annually flooded with six inches or more of water. It is on the ROW and also impact a drainfield	San Juan County	-123.0774749	48.50499367
False Bay	Ponding	Catch Basin needs to be cleaned. I removed 1"-2" of pine needles and debris with my foot but water cannot enter this CB. I walk past this location on my route to work most every day, many children take this route to school. CB @ 1000 Lampard Rd	Town of Friday Harbor	-123.0295066	48.53065918

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
False Bay	Water Quality	a while back, just after the county chip-sealed of false bay road, I was walking where the creek flows into false bay at low tide and saw oil sheen over large (1000's of square feet) areas of intertidal	San Juan County	-123.0661497	48.48889042
Fisherman Bay	Other	The ditch that runs along Village Rd flows into a large culvert at this point, which is large enough for pets or small children to fit. During a flood event, if someone small slipped into the current they could easily get swept into it. Grate?	San Juan County	-122.9124484	48.5237082
Fisherman Bay	Other	Pulling shoulders results in scraping of the driveways and the water runs and erodes the driveway rather than flowing down to the ditches and the driveway culvert	San Juan County	-122.9250911	48.49916114
Fisherman Bay	Other	Pulling ditches is scalping the driveways in this area. results in water running over drive rather than in the ditch	San Juan County	-122.9252341	48.49900988
Fisherman Bay	Private Property Damage	Run-off from Channel Road and Woodman Hall areas is diverted by county culverts onto Apple Tree Lane properties which results in flooding of those properties during heavy rains.	San Juan County	-122.9283495	48.50168285
Fisherman Bay	Water Quality	Excess water retained along Channel Road and along driveway entry. Water does not drain away and we have standing water in the culvert and along Channel Road on both sides of the driveway. Driveway is on North side of Channel Road.	San Juan County	-122.9316965	48.49278751
Friday Harbor	Erosion	This section of Hillcrest PL is unpaved with a steep decline. Stormwater races to the bottom intersection with Smoots Alley. 1-2" deep and wide gouges are not uncommon after heavy rain. The erosion here is constant and unmitigated.	Town of Friday Harbor	-123.0292912	48.53571055
Friday Harbor	Erosion	Corner Scenic Pl and Smoots Alley. Unpaved bottom of moderate decline. Significant unmitigated erosion after every rainfall.	Town of Friday Harbor	-123.0280805	48.5355621
Friday Harbor	Erosion	Beach erosion when flow through the upland swale. Also no culvert under this drive at the end of ditch causing flooding at the upland end of the swale	San Juan County	-122.9800516	48.52841644
Friday Harbor	Erosion	field between Nash St and marketplace is draining across Nash St and cutting a ditch in the roadway which is a major route for bicycles. also, there are many potholes in the gravel roadway	Town of Friday Harbor	-123.0191312	48.52911036

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Friday Harbor	Erosion	We live at 750 Harbor Street and there is a storm water ditch that runs through our back yard and has caused erosion. I have also seen soap (full suds) in the water, so who knows that is being dumped in there.	Town of Friday Harbor	-123.0258884	48.53860289
Friday Harbor	Erosion	Pond outlet is at a right angled to the road. eroding the road base. Ditch erosion along uphill side of the road.	San Juan County	-122.9802994	48.52709757
Friday Harbor	Flooding	Every time there is excessive rainfall the yard retains water. The drainage ditch that runs from the Opalco yard to Carter is choked with growth and debris that should be cleared for better/increased flow.	Town of Friday Harbor	-123.0310646	48.53913459
Friday Harbor	Flooding	Backyard has 1-2" standing water, plus corner common to 1001 Terra Bella has 6"+ water. Drainage ditch from OPALCO to Carter should be cleared of growth and debris to avoid water backup into yards.	Town of Friday Harbor	-123.0299116	48.53910771
Friday Harbor	Flooding	We are having trouble with water from the condo's storm water. It was never hooked up to the storm water system so all the water comes down to our house below at 475 Marble.	Town of Friday Harbor	-123.0203184	48.54048505
Friday Harbor	Flooding	Nash Street - gravel section between Market and Spruce Streets. Appears either ditch maintenance has lapsed or storm water was never dealt with there.	Town of Friday Harbor	-123.0191842	48.52947094
Friday Harbor	Flooding	Beaverton Valley Road on the south side between SaltSpring Drive and Scheffer Drive. The ditch is inadequate and it floods over into the road even when there is a continual modest rainfall for a while. Thus, caused hydroplaning of tires.	San Juan County	-123.0548472	48.53987048
Friday Harbor	Flooding	Adding this photo to the nearby comment	Town of Friday Harbor	-123.0301521	48.54027913
Friday Harbor	Nuisance	sewage smell from grate between cannery condos and cannery shops	Town of Friday Harbor	-123.0143662	48.53485593
Friday Harbor	Nuisance	sewage smell from grate in parking lot between cannery condos and cannery shops	Town of Friday Harbor	-123.0143662	48.53485593
Friday Harbor	Other	435 Argyle--parking lot behind building. When it rains, the storm drain bubbles up, pumping water out rather than draining; creates a pond sometimes 15-20 feet across and making access to rear of building difficult.	Town of Friday Harbor	-123.0177821	48.53209942
Friday Harbor	Other	Small capacity pipe causes yard flooding up stream. further backup flows through the swale to beach.	San Juan County	-122.9821821	48.5287654

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Friday Harbor	Ponding	Ponding water nest to the house and fence	Town of Friday Harbor	-123.0101543	48.530414
Friday Harbor	Ponding	Ponding on this corner is impacting the usability of the road and causing damage to the road	Town of Friday Harbor	-123.0300568	48.54039007
Friday Harbor	Water Quality	Smell of petroleum product traveling across our property West to East behind bamboo at front gate, and across driveway and northeast on Pear Point	San Juan County	-122.9755845	48.52748138
Griffin Bay	Erosion	Discharge at this point is eroding the road bed of the County and or the private road	San Juan County	-123.0231826	48.50084396
Griffin Bay	Flooding	Area residents have reported flooding of homes downslope of this ditch during high rainfall and pond maintenance activities.	San Juan County	-123.0228292	48.51238728
Griffin Bay	Flooding	Ditch needs to be cleaned out and made deeper on an ongoing basis	San Juan County	-123.0232565	48.51164981
Griffin Bay	Flooding	flooding occurring in this area from sheet flow on the west side and moving over or under the road and affecting a number of homes in the area	San Juan County	-123.0174825	48.52240856
Griffin Bay	Flooding	clear cutting and earth moving across from 491 Golf Course Road has caused a change in drainage. Needs for onsite retention so our property does not become "Lake Bennett" after heavy rain.	San Juan County	-123.022341	48.50380947
Griffin Bay	Public Property Damage	Ditch blocked on east side of road so run-off flows onto the street and contributes to potholes in front of 124 Apple Tree Ln.	San Juan County	-123.0191426	48.52396367
Griffin Bay	Water Quality	slick nasty petroleum looking substance coating standing water and puddles, especially on the back side of the field behind the business park	San Juan County	-123.0153932	48.52515949
Guthrie and Grindstone Coves	Erosion	Intersection of Stonecrop Road/Hawthorne Lane and Killebrew Lake Road. Rainwater over flow culvert washing out road and flowing over Killebrew Lake Road eroding bank on south side of Killebrew Lake Road.	San Juan County	-122.9337633	48.60008305
Guthrie and Grindstone Coves	Other	oil seeping up in this area	San Juan County	-122.9204098	48.61003632
Guthrie and Grindstone Coves	Ponding	ponding on north side of the road seeps and overflows road. About 20 meter long area ponding in March	San Juan County	-122.9218749	48.60935433
Haro Strait	Erosion	Around this area, rapidly moving floodwater hitting up against the road	San Juan County	-123.1271867	48.49991344

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Haro Strait	Other	I have problem with being assessed with stormwater. My home is on fractured rock. When it rains there is NO runoff. The rainfall disappears in the area in which it falls. I should not have to pay for something that doesn't happen.	San Juan County	-123.1518552	48.52767672
Haro Strait	Ponding	During heavy rainfall on the roadway on the east side ponds with water. This is where trucks make the wide left turn to go down to the quarry.	San Juan County	-123.1370677	48.55512774
Juan de Fuca Strait	Other	There is a 2 feet diameter hole in the dam of Panorama Pond, N side of False Bay Drive. It's slowing getting bigger, draining water from the pond, could lead to flooding particularly if the dam fails.	San Juan County	-123.0375676	48.48189142
Lopez Sound	Ponding	A truck went off the road last year and impacted the integrity of the ditch. Stormwater tends to pond here, threatening to flow on to the road and private property during large rain events.	San Juan County	-122.8662745	48.52054964
Lopez Sound	Water Quality	This seasonal creek drains a large area to the west including grazing and haying fields. Cow manure and waterfowl likely causes water quality issues. This creek drains to Lopez Sound to the east potentially affecting clam and shellfish resources.	San Juan County	-122.8664035	48.52400921
North Shore	Erosion	Severe snowmelt-caused erosion between School Rd and parking area in front of elementary school	San Juan County	-122.9036853	48.698581
North Shore	Erosion	At various points along the new trail (installed 2013) along Mount Baker Road there are many places that rainwater is washing away the soil laid at the sides of the path and the road. Please address this to ensure the longevity of this great path!	San Juan County	-122.9024766	48.70305026
North Shore	Flooding	Since completion of Mt Baker Rd project storm water flowing into my pond has substantially increased. The pond level is close to breaching the dam. 412 Mt Baker Rd.	San Juan County	-122.895713	48.71143208
North Shore	Flooding	Culvert appears clogged under pedestrian path at corner of Enchanted Forest and Lavender Hollow (Orion). Water flooding onto roadway	San Juan County	-122.9090515	48.69958018
North Shore	Flooding	it appears culvert is too small to handle flow at S. entry to Opalco substation on Lovers Lane	San Juan County	-122.9118623	48.70120939

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
North Shore	Flooding	A drainage culvert was installed under Blanchard Rd and a trench was then dug from the road directly to our property. It is currently diverting most of the runoff from Blanchard road directly onto our property, causing significant flooding.	San Juan County	-122.9168362	48.71200397
North Shore	Flooding	The Port of Orcas Wetland is flooded like I have never seen in past 10 years.	San Juan County	-122.9123161	48.711692
North Shore	Flooding	Ever since the houses were built across the street water sheets as it flows North on North Beach and enters our property at the driveways, bringing water to a foot high or more above grade covering many several areas equaling 600 sf Please help!	San Juan County	-122.9065053	48.70975635
North Shore	Other	Lack of slope. County ditch does not slope properly resulting in ponding.	San Juan County	-122.9150277	48.70349401
North Shore	Other	Plugged culvert causing water running on the road	San Juan County	-122.9174995	48.69916132
North Shore	Ponding	As North Beach gets built up, water no longer flows along the side of the road like a gutter, it just flows in our driveways into yard pooling up 12-14 in. deep over a huge area after even a medium rain.	San Juan County	-122.9065198	48.70926483
Presidents Channel	Flooding	Flooding from neighbors pond and upland development. Past ditching efforts did not resolve the problem. (via e-mail)	San Juan County	-122.9380333	48.69346207
Raccoon Point	Flooding	Since Mt Baker Rd rebuild, water ponds on the north side of Mt Baker Rd between the covered bridge and Dr. Bailey's office whenever there is heavy rain or snowmelt. The water sometimes extends out into the roadway.	San Juan County	-122.891249	48.70314786
Raccoon Point	Flooding	This flat area west of the Road has experienced repeated kneed deep flooding in drive ways and yard and has flooded some structures, primarily out buildings.	San Juan County	-122.887551	48.69797999
Raccoon Point	Other	outfall halfpipe rusted out. Entire bank on the beach has multiple ground water seeps. Old pond discharges to a road ditch on a private road.	San Juan County	-122.8687724	48.70688189
San Juan Channel (San Juan)	Erosion	The length of Cypress Heights suffers erosion every time we get heavy rain. "Ditches" form all the way down the road, and a large puddle creates a growing pothole when it fails to drain into the ditch at the intersection with San Juan Drive.	San Juan County	-123.104696	48.6077676

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
San Juan Channel (San Juan)	Flooding	There is a drainage ditch that goes through this area from Three Meadows through a culvert, under Roche Harbor Rd and continues to the sea. Possibly the section in Eureka area needs cleaning to facilitate draining.	San Juan County	-123.0612387	48.56360362
San Juan Channel (San Juan)	Flooding	Multiple spots along this road have minor flooding during significant rainfall. Water has been sheet flowing across the road at times.	San Juan County	-123.0834925	48.56626933
Shaw Island	Erosion	north side of causeway at Neck Point, Shaw Island. Bulkhead on north side has failed and winter high water eroding fill material to within 1 foot of roadway. A second temporary repair recommended.	San Juan County	-123.0115828	48.58093853
Shaw Island	Flooding	Run off from roads at ferry landing. Rain garden a possibility.	San Juan County	-122.9282549	48.5845301
Shaw Island	Flooding	Culvert appears to be blocked, causing water to pool on roadway. Possibly caused by recent mower activity by county?	San Juan County	-122.9290559	48.57713545
Shaw Island	Flooding	Water over road. Ditch on the north side overtopping and water moving south.	San Juan County	-122.933425	48.5654325
Shaw Island	Flooding	Water drains off the hillside and onto the County road.	San Juan County	-122.9451631	48.56217094
Shoal Bay	Environmental Damage	Stormwater runoff from the ferry holding area is terrible. With every rain, oil, gasoline, and other pollutants from vehicles can be seen running down the hill and into the storm drain, which I presume dumps directly into the coastal sea	San Juan County	-122.8841122	48.56929226
Shoal Bay	Flooding	Culvert under ferry road drains onto lot and floods the upper lot. Then flows down toward structure on the primary lot on Sea Ranch road	San Juan County	-122.8856869	48.56632439
Spieden Channel	Other	multiple curtain drain connections use ditch capacity and erode the ditches.	San Juan County	-123.1072207	48.61973679
Swift Bay	Flooding	Probably more a road issue, but there is a big puddle that forms on the right side of the Northbound Lane of Center Rd here. It could cause hydroplaning or ice in the right conditions.	San Juan County	-122.8934484	48.51214195
Swift Bay	Ponding	Ditch has not been cleaned out. Water pond in ditch and then flows south and into front yard	San Juan County	-122.8964608	48.53533146

Table C-1 (continued). Stormwater Issues.					
Watershed	**Stormwater Issue**	**Comments**	**Jurisdiction**	**Longitude**	**Latitude**
Swift Bay	Private Property Damage	water flows through a culvert from north side of cross road to an existing inadequate ditch running e-w on south side of cross road. ditch does not drain resulting in overflow onto 222 cross road causing flooding, pooling and sinking concrete.	San Juan County	-122.8981968	48.53606552
West Sound	Erosion	Road culvert is directing water to this area and is flooding the area and the drainage rills are eroding. the area is approximately 3 acres	San Juan County	-122.9469185	48.60543109
West Sound	Flooding	Rainwater from Killebrew Lake Road is eroding the bank above the Bay Head Marina parking lot and floods the parking lot.	San Juan County	-122.9381675	48.59802259
West Sound	Flooding	Flood water discharged behind Landmark Inn floods shared private access road to Alder Forest Cottages during all heavy rains	San Juan County	-122.9894673	48.64753518
West Sound	Flooding	Flooding and ponding of entire property during the winter rains from properties to the north and west, and from road runoff in the ditches. Flooding has increased over the past few years with more development and tree removal on the uphill properties	San Juan County	-122.9618946	48.6341645
West Sound	Private Property Damage	Flows from recent development results in increased flows onto this area.	San Juan County	-122.9539605	48.63387423

Table C-2. Stormwater Issues.										
Watershed	Total	Environmental Damage	Erosion	Flooding	Nuisance	Ponding	Private Property Damage	Public Property Damage	Water Quality	Other
Deer Harbor	3			3						
Doe Bay	2			1			1			
Eastsound	41		9	13	1	6	8			4
False Bay	7		3			2			1	1
Fisherman Bay	5						1		1	3
Friday Harbor	19		6	6	2	2			1	2
Griffin Bay	7		1	4				1	1	
Guthrie and Grindstone Coves	3		1			1				1
Haro Strait	3		1			1				1
Juan de Fuca Strait	1									1
Lopez Sound	2					1			1	
North Shore	11		2	6		1				2
Presidents Channel	1			1						
Raccoon Point	3			2						1
San Juan Channel (San Juan)	3		1	2						
Shaw Island	5		1	4						
Shoal Bay	2	1		1						
Spieden Channel	1									1
Swift Bay	3			1		1	1			
West Sound	5		1	3			1			
Total	127	1	26	47	3	15	12	1	5	17